Chapter Five: Reasonably Foreseeable Effects of Sale 87

Contents

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This chapter and the one following it describe the ways in which lease activity resulting from Sale 87 may change the environment and affect its people. The key to understanding the potential for effects lies in understanding the culture, communities, and economy of the North Slope Borough (Chapter Four). Equally important is knowledge of the surrounding natural environment (Chapters Two & Three).

Section A of this chapter describes current methods of oil and gas exploration, development and production in the Arctic. Transportation and accidental discharge of oil and gas are specific issues described in Chapter Six. Section B analyzes effects of oil and gas activities on historic resources, subsistence uses, and fish and wildlife populations of the Sale 87 area. Sections C and D discuss the reasonably foreseeable effects on municipalities and communities, and fiscal effects of this sale. This chapter combines current knowledge of oil field development impacts in the Arctic with the past, present, and reasonably foreseeable future effects of oil and gas lease Sale 87.

Potential bidders begin the process by weighing the costs and benefits of obtaining and keeping the lease. They acquire and analyze existing data, conduct geophysical exploration, estimate the volume and type of recoverable reserves, estimate the cost of developing reserves, and attempt to calculate the expected return on their investment. These considerations may be weighed in light of other factors, such as the state's current leasing policy, schedule of future sales, or competing projects, such as developing prospects overseas. Considering all these variables, it is impossible to predict which tracts will be bid upon and leased.

Strategies used to explore for, develop, produce, and transport potential petroleum resources will vary, depending on factors unique to the individual tract, lessee, operator, or discovery. If a commercially developable deposit is found, any development would require construction of one or more drillsites. If mineral resources can be developed, construction of pipelines would be likely, and other production and transportation facilities would also be necessary. Some new roads may be required, and machinery, labor, and housing would be transported to project sites.

The state of Alaska as a whole, the NSB, and the communities of Nuiqsut, Kaktovik, Anaktuvuk Pass, and Barrow may experience effects of activities following this sale in both monetary and non-cash terms. Impacts to the North Slope region may be minuscule. However, local impacts might be significant. Potential effects include:

- Erosion
- Use conflicts
- Disturbance to wildlife
- Oil spills
- Alteration of hydrology
- Loss of fish and wildlife
- Increased noise and traffic
- Habitat loss or change
- Environmental studies
- Water quality changes
- Chemical/pollutant releases
- Impacts to human environment
- Air quality degradation
- Siltation
- Employment opportunities
- Road, dock, airstrip, sanitary & utilities construction
- State petroleum tax & royalty revenues
- Local oil and gas property tax revenues

Most adverse effects would be temporary and may occur during development, and not during exploration and production phases. Positive effects occur at all phases and fiscal benefits of petroleum extraction may last several decades. All lease-related activities are subject to applicable local, state, and federal statutes, regulations, and ordinances, and subject to lease mitigation measures. Implementation of any exploration and development program must meet the requirements of regulatory agencies prior to approval. Permit requirements must be evaluated in light of the particular activity proposed, and plans of operation must be approved with appropriate project-specific and site-specific safeguards.

DO&G has developed general mitigation measures to minimize pollution and habitat degradation, and disturbance to fish and wildlife species, subsistence uses, and local residents. Additional project-specific and site-specific mitigation measures will be applied to particular exploration and development proposals as additional information becomes available. Despite these protective measures, some impacts may occur. In this chapter, potential impacts are discussed, and measures to mitigate future impacts are summarized. For a full text listing of Sale 87 mitigation measures see Chapter Seven.

A. Post Lease Sale Phases

Lease-related activities proceed in phases; each subsequent phase's activities depend on the completion or initiation of the preceding phase. Table 5.1 lists activities that may occur during these phases.

Table 5.1 Activities That May Be Found At Post Lease Sale Phases

Exploration	water usage permitting environmental studies seismic tests exploratory drilling rigs ice roads & ice pads marine vessel support drilling muds gravel pads (rare) worker camps increased air traffic
Development	permitting environmental studies research and analysis gravel pits, pads and roads dock, bridge, and facility construction buried & elevated pipelines drilling rigs work camps increased air and vessel traffic air emissions
Production	permitting monitoring well workovers injection wells: gas and sea water gravel pads and roads produced water injection air emissions pipeline maintenance work camps support infrastructure

1. Exploration

The purpose of exploration is to gather as much information about the petroleum potential of an area as possible. Some activities take place before the lease sale as prospective bidders evaluate the offered acreage; however most extensive exploration operations occur after the lease sale.

Exploration activities may include the following: research and monitoring, examination of the surface geology, geophysical survey programs, researching data from existing wells, performing environmental assessments, and the drilling of an exploratory well. Surface analysis includes the study of surface topography or the natural surface features of the area, near-surface structures revealed by examining and mapping exposed rock layers, and geographic features such as hills, mountains and valleys.

a. Geophysical Exploration

- Permittees shall consult the Alaska Heritage Resources Survey so that known historic and archaeological sites may be avoided.

- The permittee remains responsible for obtaining the approval of other surface or subsurface interest holders, individuals, companies, and agencies as may also be required. For example, operations within or crossing the Trans-Alaska Pipeline corridor require prior authorization from Alyeska.
- The provisions of the federal and state Endangered Species Acts and the federal Marine Mammal Protection Act must be adhered to at all times. The Endangered Species Act provides that there will be no activity permitted that jeopardizes the continued existence of an endangered species or results in the destruction or adverse modification of habitat of such species. The applicant is advised to contact the Anchorage U.S. Fish and Wildlife Service, Endangered Species Office for additional information on endangered species.
- The use of ground contact vehicles for off-road travel is subject to regional openings and closure notices issued by ADNR. Operations are restricted to the winter seasonal opening. After April 15, the use of ground contact vehicles is subject to termination within 72 hours of written notification from ADNR.
- Vehicles shall be operated in a manner such that the vegetative mat is not disturbed, and blading or removal of vegetative cover is prohibited except as approved by ADNR. Filling of low spots and smoothing using snow and ice is allowed.
- Movement of equipment through willow (Salix) stands must be avoided wherever possible.
- Equipment, other than vessels, must not enter open water areas of a watercourse during winter. Ice or snow bridges and approach ramps constructed at river, slough, or stream crossings must be substantially free of extraneous material (i.e., soil, rock, wood, or vegetation) and must be removed or breached before spring breakup. Alterations of the banks of a watercourse are prohibited.
- Secondary containment shall be provided for fuel or hazardous substances. Rules apply to the use of container marking, surface liners, and the storage, handling and transfer of fuel.
- Oil spills must be reported immediately. All fires and explosions must also be reported.
- Trails, campsites and work areas must be kept clean. Trash, survey lath markers, and other debris that accumulates in camps, along seismic lines, and travel routes, that is not recovered during the initial cleanup, shall be picked up and properly disposed of prior to freeze-up the following winter. All solid wastes, including incinerator residue, shall be backhauled to a solid waste disposal site approved by ADEC.
- Operations must avoid occupied grizzly bear dens by one-half mile unless alternative mitigative measures to minimize disturbance are authorized by ADNR after consultation with ADF&G. Known den locations shall be obtained from ADF&G prior to starting operations. Occupied dens encountered in the field must be reported to the above, and subsequently avoided.
- Operations must avoid known polar bear dens by one mile. Known den locations shall be obtained from the U.S. Fish and Wildlife Service prior to starting operations. New dens encountered in the field must be reported to the above, and subsequently avoided by one mile.

Vehicle maintenance, campsites and/or storage and stockpiling of material on surface ice of lakes, ponds, or rivers is prohibited. To avoid additional freeze-down of deep-water pools harboring overwintering fish, watercourses shall be crossed at shallow riffle areas from point bar to point bar. Compaction or removal of the insulating snow cover from the deep-water pool areas of rivers must be avoided. Geophysical exploration of the Sale 87 area has been ongoing for several decades. Usually, geophysical companies conduct seismic surveys under contract with lease holders. Contracts may have provisions that allow the geophysical company to sell the data to other interested companies. Geophysical programs may take place before or after a lease sale. If sufficient data are already available, additional seismic data acquisition may not be necessary. Lessees may or may not propose operations which include seismic surveys in the Sale 87 lease area.

Geophysical exploration activities are regulated by 11 AAC 96 and permits are tailored specifically for each project. Restrictions on geophysical exploration permits depend on the duration, location and intensity of the project. They also depend on the potential effects the activity may have on important habitat and species, such as caribou and waterbirds. The extent of effects on important species varies depending on the survey method and the time of year the operation is conducted. Geophysical surveys help reveal what the subsurface looks like and help locate subsurface hazards.

The geophysical survey process involves sending energy into the earth or using an energy wave generating method, such as Vibroseis. Vibroseis generates waves of continuously varying frequency. The energy waves bounce back from the various rock layers and are received and changed into electrical impulses by listening devices called geophones. The impulses are recorded on computer tape, processed on high speed computers, and displayed in the form of a seismic reflection profile. Geophysicists then analyze the profile to determine subsurface features. Other sources of energy include explosive charges, however this method has largely given way to the Vibroseis method, and their use on the North Slope is rare.

Vibroseis components are usually mounted on trucks with large tires or tracked vehicles. Snow plows may be required in advance of these source units when snow is deep. Supply vehicles for crews may include 6-wheel drive articulating buggies with a 2,500 gallon fuel tank mounted on them and a crane for moving heavy parcels. These supply crews with fuel, water, groceries, parts, and personnel. Between 2 and 5 supply units may be used for each seismic survey depending on the size of the survey, whether it is 2-D or 3-D, and depending on the distance from a fuel source. Camps consist of strings of trailers hooked together and pulled where necessary by Caterpillar tractors. Each camp is equipped with generators, a kitchen, diner, wash house, recreation room, crew office, survey office, mechanic's shop, geophone and cable repair shop, dry stores, part house, and sleeping quarters. Camps also may include one or more fuel sleds, an incinerator, a snow melter for making water, and a steamer unit. Camps can house approximately 60 persons at a time for a 2-D survey, and 100 persons for a 3-D survey. Camps use between 2,800 to 3,300 gallons of fuel per day and 2,000 to 3,000 gallons of water per day (Rice, 1997).

Standard permit conditions for North Slope seismic operations are designed to protect resource values and ensure compliance with the Alaska Coastal Management Program.

- All aircraft shall maintain an altitude of 1,500 feet or a lateral distance of one mile, excluding takeoffs and landings, from caribou and muskoxen concentrations.

b. Exploration Drilling

Exploratory drilling only occurs after seismic surveys are conducted which may reveal petroleum potential. If geophysical exploration studies indicate the possibility that oil or gas may be present, lessees may initiate the drilling of an exploration well. The only way to learn whether or not commercial quantities of oil or gas are present in the rock formations beneath a lease is by drilling. Exploratory drilling happens after the lease sale (after mineral rights have been secured) and after preliminary exploration activities reveal the most likely places to find oil or gas. Occasionally in unexplored areas, companies have joined together to drill a stratigraphic test well (a test which merely determines subsurface layers) prior to the lease sale in order to gather information. However, this is rarely, if ever, done these days. Companies usually gather as much information as they can using less expensive methods and secure the lease before drilling an exploratory well.

Onshore exploratory drilling operations on the North Slope almost always occur in winter to minimize impact and reduce costs. Temporary roads are constructed of ice by adding water to the surface which freezes into a form that can support heavy loads. Mitigation Measure 6 states that exploration facilities, must be temporary and must be constructed of ice unless the Director determines that no feasible and prudent alternative exists. In extraordinary circumstances, permanent roads made of sand and gravel may be permitted. A drill site is selected to provide access to the prospect to be drilled and is located to minimize impacts to any sensitive areas, such as private property or an archaeological site. The ice pad supports the drill rig assembled at the site, a fuel storage area, and a camp for 50 to 60 workers. Ice pads are approximately 500 feet by 500 feet. If the facilities are not available, a temporary camp of trailers on skids or wheels can be placed on the pad. Ice road and pad construction begins during middle to late December when ambient temperatures are cold enough for relatively fast construction (Hazen, 1997). Potential impacts of ice pads on tundra are discussed in Section B.

Exploratory drilling generates information for the lessee which will aid in the decision whether to proceed to the development phase. Drilling operations collect core samples, well logs, cuttings, and various test results. Cores may be cut at various intervals so that geologists and engineers can examine the sequences of rock that are being drilled. Well logs are records of tests conducted by lowering various instruments into the well bore.

If the exploratory well is successful, the operator will probably drill one or two more wells to delineate the extent of the discovery and gather more information about the field. The lessee needs to know how much oil and gas may be present, and must determine the quality of the rocks in which they are found to determine whether or not to proceed to the next phase. The extent and location of offshore exploratory and delineation drilling depends on petroleum potential (BPX, 1996).

The drilling process is as follows:

1. Special steel pipe, conductor casing, is bored into the soil.
2. The bit rotates on the drill pipe to drill a hole through the rock formations below the surface and into the lease.
3. Blowout preventers are installed on the surface and only removed when the well is plugged and abandoned. Blowout preventers are large, high-strength valves which close hydraulically on the drill pipe to prevent the escape of fluids to the surface. (ARCO, Undated: 80-84)
4. Progressively smaller sizes of steel pipe, called casing, are lowered into the hole and cemented in place to keep the hole from caving in, to seal off rock formations, seal the well bore from groundwater, and to provide a conduit from the bottom of the hole to the drilling rig.

An exploratory drilling operation generates approximately 12,000 cubic feet of drilling solids. Cuttings are fragments of rock cut by the drill bit. These fragments are carried up from the drill bit by the mud pumped into the well (Gerding, 1986: 97-174). Also produced from drilling operations are gas, formation water, and fluids and additives used in the drilling process. The fluids pumped down the well are called mud, and different formulations are used to meet the various conditions encountered in the well. Muds are naturally occurring clays and small amounts of biologically inert products. They cool and lubricate the drill bit, prevent the drill pipe from sticking to the sides of the hole, seal off cracks in down-hole formations to prevent the flow of drilling fluids into those formations, and carry cuttings to the surface (ARCO, Undated: 80-84).

The state discourages the use of permanent reserve pits and most operators store drilling solids and fluids in tanks until they can be disposed of, generally down the annulus of the well, in accordance with 20 AAC 25.080. Frozen cuttings may also be temporarily stored on the pad. In most circumstances, the cuttings are transported to a grind and inject facility. If necessary, a flare pit may be constructed to allow for the safe venting of natural gas that may emerge from the well. If the exploratory well discovers oil, it is likely that the pad used for the exploratory well will also be used for production testing operations.

Mitigation measure 17b regulates the disposal of muds and cuttings. The preferred method for disposal of muds and cuttings from oil and gas activities is by underground injection. Injection of non-hazardous oil field wastes generated during development is regulated by AOGCC through its Underground Injection Control (UIC) Program for oil and gas wells. Annular disposal of muds and cuttings associated with drilling an exploratory well is permitted by ADEC. Surface discharge of drilling muds and cuttings into lakes, streams, rivers, and high value wetlands is prohibited. Surface discharge of drilling muds and cuttings into reserve pits shall be allowed only when the Director, in consultation with ADEC, determines that alternative disposal methods are not feasible and prudent. If use of a reserve pit is proposed, the operator must demonstrate the advantages of a reserve pit over other disposal methods, and describe methods to be employed to reduce the disposed volume. Onpad temporary cuttings storage will be allowed as necessary to facilitate annular injection and/or backhaul operations.

Mitigation measure 18 regulates the disposal of produced water and other wastewater. Disposal of produced waters in upland areas, including wetlands, will be by subsurface disposal techniques. ADEC may permit alternate disposal methods if the lessee demonstrates that subsurface disposal is not feasible or prudent. Surface discharge of reserve pit fluids will be prohibited unless authorized by ADEC permit and approved by DL.

2. Development and Production

The development and production phases are interrelated and overlap in time; therefore, this section discusses them together. During the development phase, operators evaluate the results of exploratory drilling and develop plans to bring the discovery into production. Production operations bring well fluids to the surface and prepare them for transport to the processing plant or refinery. These phases can begin only after exploration has been completed and tests show that a discovery is economically viable. (Gerding, 1986: 177-199)

After designing the facilities, the operator constructs permanent structures and drill production wells (See Figure 5.1). The operator must build production structures that will last the life of the field and may have to design and add new facilities for enhanced recovery operations as production proceeds. Gravel pads are semi-permanent structures used for production facilities and can be rehabilitated following field depletion.

The development "footprint" in terms of habitat loss or gravel filling has decreased in recent years as advances in drilling technology have led to smaller, more consolidated pad sizes. A single production pad and several directionally drilled wells can develop more than one and possibly several 640 acre sections. Unless pool rules (oil or gas field rules governing well drilling, casing, and spacing which are designed to maximize recovery and minimize waste) have been adopted under 20 AAC 25.520, existing spacing rules stipulate that where oil has been discovered, not more than one well may be drilled to that pool on any governmental quarter section (20 AAC 25.055(a)). This would theoretically allow a maximum of four well sites per 640 acre section. Where gas has been discovered, not more than one well per section may be drilled into the pool. (See Figure 5.2)

Production facilities will likely include several production wells, water injectors, gas injection wells, and a waste disposal well. Wellhead spacing may be as little as 10 feet. A separation facility would remove water and gas from the produced crude, and pipelines would carry the crude to the Trans-Alaska Pipeline System (TAPS). Some of the natural gas produced is used to power equipment on the facility but most is re-injected to maintain reservoir pressure. Produced water is also reinjected. Often, sea water is treated and injected into the reservoir in order to maintain pressure, improve recovery, and replace produced fluids. Produced water is treated to remove sand and other particles. Sea water is filtered to remove solids and dissolved oxygen.

Figure 5.1 Typical Projection/Injection Well

Figure 5.2 Evolving Consolidation of North Slope Production Pad Size

and

Figure 5.3 Drill Site Block Diagram

3. Directional Drilling

Directional drilling is the science of deviating a well bore along a planned course to a subsurface target whose location is a given lateral distance and direction from the vertical (Schlumberger Anadrill, 1993:1). Directional drilling allows multiple production and injection wells to be drilled from a single location such as a gravel pad or offshore production platform, thus minimizing cost and the surface impact of oil and gas drilling, production, and transportation facilities. It can be used to reach a target located beneath an environmentally sensitive area and may offer the most economical way to develop offshore oil fields (ADNR, 1995:D-1). However, using directional drilling to reach just one target increases drilling costs relative to a vertical straight hole. (See Figure 5.4)

The limitations of directional drilling are primarily dependent upon maximum hole angle and rate of angle change. In directional drilling, it is now common for the drill to go an equal vertical depth related to the horizontal distance from the drill site. That is, a well 7,000 feet deep would have a bottom hole horizontal displacement of 7,000 feet from the drill site. If a potential target is two miles away from the drill site but only one mile deep, directional drilling would be much more difficult and costly. Drilling long horizontal distances is called “extended-reach drilling.” The maximum horizontal drilling capacity may also be limited by the type of geology or rock that must be drilled in order to reach a target. For example, coal and shale deposits tend to collapse and faults are difficult to drill through. If a fault is crossed by the drill bit, the type of rock being drilled may suddenly change and a new geologic reference must be established. During this intermediate period in the drilling operation, the driller will not be sure if the desired geologic target was being or could be intersected. Some faults are difficult or impossible to cross because of fluid and cement losses to them.

While a 23,911 foot horizontal displacement was accomplished in 1993 in the North Sea (Petroleum Engineer International, 1994:25), horizontal displacements of one-half mile to two miles are more typical. Current development wells in Cook Inlet and on the North Slope have been drilled with displacements in excess of 10,000 feet at total depth of approximately 10,000 feet vertical (Schmidt, 1994). Horizontal displacement of up to 15,000 feet at vertical depths of 7,000 to 9,000 feet are the current planning standard for the North Slope providing the subsurface geology permits it. Recently, ARCO Alaska, Inc. has set a long-reach record for horizontal directional wells in the U.S. with a displacement (departure from vertical) of 18,098 ft. in the Niakuk Field (PIC, 1996) (See Figure 5.4). The world record for an extended reach well is 26,338 feet at BP’s Wytch Farm Field in the United Kingdom (Peninsula Clarion, 1996).

Directional wells drilled from conventional drilling rigs are initiated as vertical holes and then gradually deviated from the vertical. This gradual change in wellbore angle is necessary to control drilling direction, to avoid mechanical fatigue problems and in order to install and operate down-hole test and production equipment (Schmidt, 1994).

Although directional drilling is technically possible it is not always economically feasible. Factors such as where the oil deposit is in relation to the drilling rig, the size and depth of the deposit, and the geology of the area, are all important elements in determining whether directional drilling is cost effective (Winfree, 1994).

The Sale 87 area may include some environmentally sensitive areas which might be reached from less sensitive locations via directional drilling technology. It is possible that future onshore exploration wells within the sale area may be directionally drilled due to a lack of suitable surface locations overlying exploration targets. However, until specific sites and development scenarios are advanced and the specific conditions of drill sites are known, the applicability of directional drilling for oil and gas within the Sale 87 area is unknown. Most wells in the sale area will be directionally drilled because of the cost savings realized in pad construction, and in required facilities. Many surface use conflicts can be avoided through directional drilling. However, some reservoirs are located or sized such that directional drilling may not eliminate all conflicts.

Figure 5.4 Well Reach vs. Time

B. Cumulative Effects

AS 38.05.035(g) requires DNR to consider and discuss the reasonably foreseeable cumulative effects of oil and gas exploration, development, production, and transportation on the sale area, including effects on subsistence uses, fish and wildlife habitat and populations and their uses, and historic and cultural resources. However, DNR is not required to speculate about possible future effects subject to future permitting that cannot reasonably be determined until a project or proposed use for which a written best interest finding is required is more specifically defined. AS 38.05.035(h).

Accordingly, in the section, DNR sets out relevant and important information which is currently known to DNR about the lease sale 87 area, and considers and discusses the reasonably foreseeable effects of additional activities which may result from Sale 87 related oil and gas exploration, development, production and transportation. By necessity, some of this discussion is general in nature. While certain activities are reasonably foreseeable because they would be components of any oil and gas activity on the North Slope, activities specific to certain areas or tracts are not reasonably foreseeable because the odds of finding and developing commercially exploitable quantities of oil or gas from any particular tract are slim.

Therefore, DNR will require numerous general mitigation measures which will be applicable to any Sale 87 activity, no matter where in the sale area. These mitigation measures provide a floor of protection, to be enhanced by more specific mitigation measures as required by any particular plan of operation which may eventually be proposed.

1. Effects on Water and Air Quality, and Land Habitat

a. Effects on Water Quality

Water quality throughout the sale area varies seasonally with changes associated with streamflow. Mean annual peak runoff occurs from late May to early July during and after break-up and elevated turbidity and suspended sediment levels are common during these months. Natural as well as man-made contaminants can result in exceedences of water quality criteria. Natural contaminants to fresh water supplies include dead fish, birds, and animals; mosquito and insect larvae; algae and other plants; bacteria; parasites such as Giardia; silt and glacial flour; arsenic, iron, manganese; and hydrogen sulfide gas (AEIDC, 1975).

Water quality characteristics which may be altered by post-sale activities include pH, total suspended solids, organic matter, calcium, magnesium, sodium, iron, nitrates, chlorine, and fluoride. Potential impacts which may alter surface water quality parameters of the sale area include accidental spills of fuel, lubricants or chemicals; increases in erosion and sedimentation causing elevated turbidity and suspended solids concentrations; and oil spills (Parametrix, 1996).

Geophysical exploration of the sale area with tracked seismic vehicles is not expected to alter water quality because seismic surveys are conducted in winter and permit conditions mitigate potential damage. Under standard DNR permit conditions for winter seismic exploration on the North Slope, the use of ground-contact vehicles for off-road travel is limited to areas where adequate ground frost and snow cover prevent damage to the ground surface. Operations are restricted to the winter seasonal opening. Equipment, other than vessels must not enter open water areas of a watercourse during winter, and any ice roads, ice bridges, or approach ramps constructed near river, slough, or stream crossings must be free of extraneous material before break-up. Alterations of the banks of a watercourse are prohibited (ADGC, 1995). Adherence to these conditions thus avoids or minimizes post-seismic increases in erosion, turbidity, and suspended solids in a drainage area.

The extent and duration of water quality degradation resulting from accidental spills depends on the type of product; the location of the spill; volume; season and duration of the spill or leak; and the effectiveness of clean-up response. Heavy equipment, such as trucks, tracked vehicles, aircraft, and tank trucks commonly use diesel fuel, gasoline, jet fuel, motor oil, hydraulic fluid, antifreeze, and other lubricants. Spills or leaks could result from accidents, such as during refueling, or from corrosion of lines (Parametrix, 1996). Under standard ADNR permit conditions for off-road activity, fuel and hazardous substances must have secondary containment apparatus. A secondary containment or surface liner must be placed under all container or vehicle fuel tank inlet and outlet points. Appropriate spill response equipment must be on hand during any transfer or handling of fuel or hazardous substances. Vehicle refueling is prohibited within the annual floodplain or tidelands (ADGC, 1995). Impacts of oil spills are discussed in Chapter Six.

Other standard DNR land use permit conditions serve to protect water quality values from facility construction and operation. Trails, campsites and work areas must be kept clean. Trash, survey markers, and other debris that may accumulate in camps or along seismic lines and travel routes that are not recovered during the initial cleanup must be picked up and properly disposed of. All solid wastes, including incinerator residue must be backhauled to a solid waste disposal site approved by ADEC. Vehicle maintenance, campsites, and the storage or stockpiling of material on the surface of lakes, ponds, or rivers are prohibited (ADGC, 1995).

The federal Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) to permit discharges of pollutants into U.S. waters by "point sources," such as industrial and municipal facilities. In Alaska, the U.S. Environmental Protection Agency issues NPDES permits, designed to maximize treatment and minimize harmful effects of discharges as water quality and technology improvements are made. ADEC certifies that these discharge permits will not violate the state's water quality standards.

The Alaska Department of Environmental Conservation issues industrial and municipal wastewater permits, and monitors wastewater discharges and the water quality of waterbodies receiving the discharges. ADEC certifies federal wastewater permits with mixing zones that allow industrial and municipal facilities to meet state water quality standards. Industrial and municipal wastewater facilities are inspected annually. ADEC also certifies U.S. Army Corps of Engineer dredge and fill permits in wetlands and navigable waters to ensure compliance with state water quality standards, and provides technical assistance for design, installation, and operation of industrial and municipal wastewater systems.

Mitigation Measures.

Several Sale 87 mitigation measures and lessee advisories serve to protect water quality from post-sale oil and gas activities. The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to water quality are:

- Tundra protection -- Winter and summer off-road vehicular traffic is restricted and must be approved in plan of operations.
- Wetland and Riparian Protection -- Lessees must avoid siting facilities in key wetlands and identified sensitive habitat areas. Onshore facilities other docks, or road and pipeline crossings, will not be sited within 500 feet of fishbearing streams. Permanent facility siting is prohibited within one-half mile of the banks of major rivers.
- Water Conservation -- Removal of water from fishbearing rivers, streams, and natural lakes shall be subject to prior written approval by DMWM and ADF&G.
- Turbidity Reduction -- Exploration facilities, with the exception of artificial gravel islands, must be temporary and must be constructed of ice. Gravel mining sites will be restricted to the minimum necessary to develop the field efficiently and with minimal environmental damage and must not be located within an active floodplain of a watercourse. Causeways and docks may not be located in river mouths or deltas.
- Drilling Waste -- Underground injection of drilling muds and cuttings is preferred method of disposal. For onshore development, produced waters must be injected. Surface discharge of drilling wastes into waterbodies and wetlands is prohibited. Discharge of produced waters in marine waters less than 10 m deep is prohibited. Unless authorized by NPDES or state permit, disposal of wastewater into freshwater bodies, including Class III, IV, VI, and VIII wetlands, is prohibited.
- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Pipelines must be designed and located to facilitate clean-up. Buffer zones of not less than 500 feet will be required to separate onshore oil storage facilities (with a capacity greater than 660 gallons) and sewage ponds from freshwater supplies, streams, and lakes and key wetlands

b. Effects on Air Quality

Air quality throughout the sale area is very good, with concentrations of regulated pollutants well below the maximum allowed under National Ambient Air Quality Standards designed to protect human health. In order to ensure that air quality standards are maintained, additional limitations on nitrogen dioxide, sulfur dioxide, and total-suspended-particulate matter are imposed on industrial sources under the provisions of the Prevention of Significant Deterioration Program, administered by EPA.

Routine activities associated with oil and gas exploration, development and production that are likely to affect air quality are emissions from construction, drilling and production. Air pollutants include nitrogen oxides (NO_X), carbon monoxide (CO), sulfur dioxide (SO_2), particulate matter (PM), and volatile organic compounds[1] (VOC) (MMS, 1995, IV.B.1-92). Effects from VOC emissions would be insignificant because of the low potential for ozone formation. Photochemical pollutants such as ozone (0_3) form in the air from the interaction of pollutants in the presence of sunshine and heat. In the upper atmosphere ozone is beneficial because it absorbs solar ultraviolet radiation. In the lower atmosphere however, it is a strong oxidizing agent and can be harmful. There is a low potential for ozone formation in the sale area because the summer time air temperatures remain relatively low (MMS, 1996a, IV.B.1-94).

Emissions, such as engine exhaust and dust would be produced by trucks, heavy construction equipment and earth moving equipment. Emissions would be generated during installation of pipelines and utility lines, excavation and transportation of gravel, mobilization and demobilization of drill rigs, and during construction of gravel pads, roads, and support facilities. Elevated levels of airborne emissions would be temporary and would diminish after construction phases are complete. Emissions would also be produced by engines or turbines used to provide power for drilling, oil pumping, and water injection. In addition, aircraft, supply boats, personnel carriers, rollogon trucks, mobile support modules, as well as intermittent operations such as mud degassing and well testing would produce emissions (MMS, 1996a, IV.B.1-93).

During tanker loading operations at the Valdez terminal, emissions would result from the tanker-exhaust stacks and fugitive losses. To operate oil storage and transfer facilities, the operators would be required to provide air quality analysis and to obtain permits which meet state and federal ambient air quality standards.

Other sources of air pollution include evaporative losses (VOC) from oil/water separators, pump and compressor seals, valves and storage tanks. Venting and flaring could be an intermittent source of VOC and SO_2 (MMS, 1995, IV.B.1-93). Gas blowouts, evaporation of spilled oil and burning of spilled oil may also affect air quality. Gas or oil blowouts may catch fire. A light, short-term coating of soot over a localized area could result from oil fires. However, soot produced from burning oil spills tends to slump and wash off vegetation in subsequent rains, limiting any health effects (MMS, 1995, IV.B.1-95).

Several kinds of atmospheric pollutants can be found in the Arctic including organic contaminants and pollutants associated with the burning of fossil fuels, smelting, and industry. There is increasing concern about these contaminants entering the Arctic food chain; a concern that researchers have been aware of since the 1970’s. Most contaminants do not originate in the Arctic, but likely result from long-range transport from lower latitudes. The U.S. EPA has initiated a regional study to collect data on atmospheric contaminants which would complement other circumpolar nations’ research efforts. Although there are published data on food chain contamination by DDT and radionuclides, there are little if any data on U.S. Arctic food web contamination from other sources (MMS, 1991).

Arctic haze is a generic term for pollutant-laden aerosols distributed throughout the polar regions in late winter and early spring. Arctic haze probably develops from both man-made contaminants reaching the Arctic from the south, and from pollutants originating from the industrialized Arctic. In late spring, these materials may be deposited on snow covered land masses. Brown snow events occur intermittently in the Arctic and are believed to be caused by industrial emissions from Asia (MMS, 1991). Despite the seasonal long-distance transport of contaminants into the Arctic, pollutant levels in the air above the sale area are still far below maximum allowable standards (MMS, 1996b:III-A-14).

[1] Volatile organic compounds are any hydrocarbon that can become a vapor at room tempereture.

It is not possible to predict at the lease sale stage the amount of pollutants produced. All industrial emissions in the Arctic U.S. must comply with the Clean Air Act (42 U.S.C. §§ 7401-7642) and state air quality standards. 18 AAC 50 provides for air quality control including permit requirements, permit review criteria, and regulation compliance criteria. 18 AAC 50.300 sets up standards for air quality at certain facilities, including oil and gas facilities, at the time of construction, operation, or modification. DO&G continues to search for, but has not found any evidence that fish or terrestrial mammal population declines are linked to industrial emissions emanating from existing north slope oil and gas facilities. Federal and state statutes and regulations that will mitigate potential impacts air quality included:

- 42 U.S.C. §§ 7401-7642. Federal Clean Air Act
- AS 46.03. Provides for environmental conservation including water and air pollution control, radiation and hazardous waste protection.
- 18 AAC 50. Provides for air quality control including permit requirements, permit review criteria, and regulation compliance criteria.
- 18 AAC 50.300. Sets up standards for air quality at certain facilities including oil and gas facilities at the time of construction, operation, or modification.

ADEC's Air Quality Maintenance program controls significant, stationary sources of air contaminants to protect and enhance air quality and abate impacts on public health and the environment. The 1970 Clean Air Act established air quality programs to regulate air emissions from stationary, mobile and other sources which pose a risk to human health and the environment. ADEC monitors compliance with regulations and air quality standards through annual inspections and uniform enforcement procedures. The agency issues operating permits to existing major facilities incorporating all applicable requirements, and issues construction permits to new large facilities and for expansions of existing facilities.

c. Effects on Land Habitat

Seismic surveys: Winter seismic surveys affect tundra vegetation depending on snow depth, vehicle type, traffic pattern, and vegetation type. Camp move trails disturb vegetation more than seismic trails. Multiple vehicles in a single narrow trail cause more disturbance than dispersed tracks. Trails in shrub-dominated tundra recover slower than other vegetation types (Jorgenson and Martin, 1997).

Winter seismic trails can compress microtopography resulting in a wetter microenvironment and decreased vegetation cover of upright shrubs (willows), lichens, and mosses. Winter seismic trails have little adverse effect on (and may possibly enhance growth of) C. aquatalis and E. angustifolium due to the resulting wetter microenvironment (Noel & Pollard, 1996, citing to Felix & Raynolds, 1989). Effects can be substantial if operations are conducted improperly. Vehicles can leave visible tracks in the tundra which should disappear and vegetation should recover within a few years. Vehicles using tight turning radii have sheared off upper layers of vegetation, but left rhizomes intact, and plants should recover. Dry snowless ridges and vegetated sand dunes are at higher risk of damage. Damage to vegetation can be avoided by limiting travel to areas with at least 6 inches of snow cover, and avoiding minimum radius turns. In areas where damage is extensive, and natural recovery not expected, restoration may be required of operators (Schultz, 1996).

A study of the impact of a 1984-1985 seismic exploration program in ANWR indicated that recovery was not complete a decade after disturbance. Trails in sedge-dominated tundra recovered well, unless initial disturbance was high. Impacts on medium and highly disturbed trails may persist for a decade or more. Such impacts include increased thaw depths, trail subsidence, shifts to wetter conditions, ruts, invasion of grasses, and decreases in shrub cover (Jorgenson and Martin, 1997).

Drilling and Production Discharges: During exploration well drilling, muds and cuttings are stored on-pad, in holding tanks, or in a temporary reserve pit, and then hauled to an approved solid waste disposal site or reinjected into the subsurface at an approved injection well. All production muds and cuttings on the North Slope are reinjected into a Class II injection well. All produced waters are reinjected either into the producing formation to enhance recovery, or into an injection well. The Underground Injection Control program is administered by AOGCC. Drilling and production discharges are expected to have no impact on tundra habitat.

Effects of Construction and Gravel Infilling: Effects of constructing production pads, roads, and pipelines include direct loss of acreage due to gravel infilling, and loss of dry tundra habitat due to entrainment and diversion of water. A secondary effect of construction activities includes dust deposition, which may reduce photosynthesis and plant growth. Construction activity involving vehicular passage (see above, Effects of Seismic), such as a rollogon, may upset the thermal balance of the permafrost beneath the tundra, especially in non-winter months. Road construction, vehicular passage, and oil spills can alter surface albedo (reflectivity of sunlight off the earth's surface) or water drainage patterns, resulting in thaw and subsidence or inundation. Such changes can affect regeneration and revegetation of certain species, and specie composition may also change after disturbance from construction activities (Linkins, et al., 1984).

After an oil field is abandoned, some level of land rehabilitation will be required to restore areas impacted by oil and gas activities. Recovery of wetlands disturbed by gravel infilling varies depending on soil moisture content and amount of available soil organic matter (Kidd, et al., 1997, citing to Jorgenson and Joyce, 1994). Removal of gravel from pads and roads is the initial step in rehabilitation. At sites on the North Slope where gravel fill has been removed, problems have emerged associated with ponding, thaw subsidence, and nutrient cycling. One method preferred by ADF&G is to remove all gravel and create pond habitat that resembles pre-construction conditions. In some cases, full gravel removal may not be the optimum recovery option. In most cases, plant cultivation is desirable with the use of plant species identified as important for waterbird habitat. While rehabilitation methods for gravel pad and roads vary depending on site-specific conditions, the overall goal of rehabilitation in the existing oil fields is to create a mosaic of moist meadows, sedge meadows, and grass marshes. Several plant cultivation treatments have been used on the North Slope including fertilizer only, native-grass cultivation, Arctophila transplantation, and sedge-plug transplantation. Optimum recovery of the tundra marsh would include reestablishing vegetation, soil microbiotic, phytoplankton, aquatic invertebrate, and wildlife communities at the impacted site (Kidd, et al., 1997).

Ice roads and Pads: Ice roads and pads cause depressions in microtopography due to compaction. The thaw depth in summer increases beneath the impacted area after melt and there is an increase in wetness due to compression. Ice roads compress and shear tussocks, which may take up to four years or more to recover. Some tussocks remain dead and damaged from ice road effects for years (Noel and Pollard, 1996, citing to Walker, et al., 1987). Ice roads and pads also affect tundra regeneration, with certain species recovering faster after summer melt than others. Most vegetation should recover within three seasons following melt. Ice road thaw depths return to pre-impact levels after several years (Noel and Pollard, 1996).

Single season ice roads melt in spring and leave little if any trace. Multi-season ice pads can result in limited short-term impact, if tundra around the perimeter of the pad thaws and is blocked from sunlight. Insulated paneling held down by fabric and timbers at the perimeter of a multi-season pad can result in sun-blockage and impeded growth. Modifications to pad design are currently being tested on the North Slope to minimize impacts to the tundra surface (Hazen, 1997).

Gas Blowouts: If a natural gas blowout occurred, plants in the immediate vicinity may be destroyed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. Insects, such as mosquitoes would also be affected or killed by a gas blow-out. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site, but is not expected to be hazardous for more than one kilometer downwind or for more than one day. Natural gas development is expected to have little to no effect on lower trophic-level organisms (MMS, 1996b: IV-L-2).

Oil Spills: Spilled oil will affect tundra depending on time of year, vegetation, and terrain. Oil spilled on the tundra will migrate both horizontally and vertically. This flow depends on factors including the volume spilled, type of cover (plant or snow), slope, presence of cracks or troughs, moisture content of soil, temperature, wind direction and velocity, thickness of the oil, discharge point, and ability of the ground to absorb the oil (Linkins, et al., 1984). The spread of oil is less when it is thicker, cooler, or is exposed to chemical weathering. If the ground temperature is less than the pour point of the oil, it will pool and be easier to contain. Absorption of the oil by the tundra itself will also limit flow and reduce the area contaminated. Experiments in Canada by MacKay, et al. (1974) revealed that mosses have high absorption capacity. Moss covered tundra can absorb more than 13 gallons of oil per square meter, compared to less than a gallon for non-moss covered tundra (Linkins, et al., 1984). If there is a vertical crack through different soil horizons, oil will migrate down to the permafrost. If no cracks are present in the soil layers beneath the tundra, oil moves laterally in the organic material, does not penetrate the silty clay loam mineral soils beneath, and oil contamination would be restricted to the top few centimeters of the soil layer. Dry soils have greater porosity and the potential for vertical movement is greater (Linkins, et al., 1984, citing to Everett, 1978). If oil penetrates the soil layers and remains in the plant root zone, longer term effects, such as mortality or reduced regeneration would occur in following summers.

Fungi are important decomposers of organic material in tundra soil. In experiments near Barrow, Campbell et al. (1973) noted that oil spilled on acid-wet meadow tundra resulted in increased yeast, and decreases in filamentous fungi populations. Large numbers of fungi have been found in association with a natural oil seep at Cape Simpson. Under the right conditions involving oxygen, temperature, moisture in the soil, and the composition of the crude being spilled, bacteria assist in the break-down of hydrocarbons in soils. Petroleum-contaminated soils are commonly treated with fertilization, raking, and tilling (bioremediation). Research is ongoing in the use of microbes to assist the natural break down of petroleum in soils and gravel (Linkins, et al., 1984) (AJC, 1996).

Mitigation Measures.

The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to land habitat organisms are:

- Tundra protection -- Winter and summer off-road vehicular traffic is restricted and must be approved in plan of operations.
- Wetland protection -- Lessees must avoid siting facilities in key wetlands and identified sensitive habitat areas.
- Habitat loss minimization -- Exploration facilities must not be constructed of gravel. Ice roads and pads are preferred structures. Gravel mining is restricted to the minimum necessary to develop the field efficiently.
- Drilling waste -- Underground injection of drilling muds and cuttings is preferred method of disposal. For onshore development, produced waters must be injected. Surface discharge of drilling wastes into waterbodies and wetlands is prohibited. Discharge of produced waters into open or ice-covered marine waters of less than 10 meters in depth is prohibited.
- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Pipelines must be designed and located to facilitate clean-up.
- Rehabilitation -- At the option of the state, all improvements such as roads, pads, and wells must be either abandoned and the sites rehabilitated by the lessee, or left intact. Any machinery, equipment, tools or materials left behind after the lease is terminated become the property of the state, and may be removed by the state at the lessees expense.

2. Effects on Fish and Wildlife Habitats, Populations, and Uses

a. Fish

Anadromous streams within the sale area include the Colville, Sagavanirktok, Shaviovik, and Kadleroshilik Rivers. The Canning River is adjacent to the eastern boundary of the sale area. Numerous other rivers and streams which flow through the sale area also support anadromous fish populations. Several species of anadromous fish spawn and overwinter in these rivers and during summer migrate to nearshore coastal waters of the sale area to feed. Migration patterns vary by species and within species by life stage (see Chapter Three). Potential effects include degradation of stream banks and erosion; reduction of or damage to overwintering areas; habitat loss due to gravel removal, facility siting, and water removal; impediments to migration; and fish kills due to oil spills.

Habitat loss: Potential impacts at all phases include erosion. Erosion results in siltation and sedimentation, which in turn may result in a reduced or altered stream flow that may affect overwintering habitat availability, and affect the ability of fish to migrate upstream. Protecting the integrity of stream bank vegetation and minimizing erosion are important elements in preserving fish habitat. Streambeds could be affected if stream banks are altered, such as damage from equipment crossings. Overwintering habitat may be limited; the Colville River provides the most consistently available overwintering habitat for anadromous fish in the sale area.

Removal of water from lakes where fish are overwintering may affect the viability of overwintering fish, and longer term effects of lake drawdown may impede the ability of fish to return to the lake in subsequent years. Removal of snow from lakes may increase the freeze depth of the ice, kill overwintering and resident fish, and adversely affect the ability of fish to utilize the lake in future years.

During development, unregulated gravel removal from fishbearing streams to support oil and gas activities could adversely impact anadromous fish they support. Gravel removal could increase sediment loads, change the stream bed course, cause instability upstream, destroy spawning habitat, and create obstacles to fish migration. Gravel removal from stream beds could also cause potential damage to overwintering fish populations. Gravel mine sites can be restored as overwintering habitat and thus add to total available fish habitat.

Causeways: Though remote, the possibility of needing a causeway into the nearshore Beaufort Sea to support development in portions of the Sale 87 area does exist, placement of causeways, particularly continuous-fill causeways into the nearshore Beaufort Sea or in river deltas can alter patterns of nearshore sediment transport, alter patterns of water discharge to the nearshore environment, and alter temperature and salinity regimes in areas near the causeway. The extent of alterations depends on the size or length of the causeway, its location relative to nearby islands and river mouths or deltas, and pre-causeway oceanographic characteristics. Minimizing alterations is accomplished by proper siting, minimal size, and by ensuring that breaches are sized and located to maximize goals. Changes to the physical environment may alter patterns of use of the deltaic area by anadromous and marine fishes. Changing marine current flow and circulation patterns result in physical changes to delta channeling and shorelines which could affect use by animals which feed on fish, such as shorebirds and waterfowl (Winters, 1996).

In the case of the West Dock causeway, the structure diverts the nearshore current along the coast, resulting in colder, more saline water entering a lagoon pass area that had been warmer and less saline before construction. Studies revealed that the oceanographic characteristics of this pass area (and lagoons) were important to fish migration. Fish catch data revealed that saltwater-intolerant fish utilize the warmer less saline nearshore zone as they migrate from the Mackenzie River system in Canada. Anadromous fish may also travel from other river deltas, such as the Colville, to feed, utilizing the lagoons shoreward of the barrier islands.

East wind-induced eddies at West Dock, which create a cell of cold, saline water in the normally warm and brackish nearshore zone, may occasionally disrupt the eastward movement of Colville River young least cisco during their summer nearshore feeding migration, but this infrequent occurrence has had no apparent effect on least cisco populations (Fechhelm et al. 1994).

After West Dock was constructed and extended (after a barge became stuck in the ice), there was concern that the structure restricted the ability of fish to avoid cold saline water during their migration. Small Arctic cisco are transported to the Prudhoe Bay area when northeast winds are sufficiently strong and long-lasting to induce longshore movement of water from the Mackenzie River in Canada (Gallaway et al. 1991). The cell of colder saline water between Stump Island and the causeway, created by eddying off the tip of the structure occurs at a key point along the migratory path. These conditions may block eastward movement around the causeway, specifically for smaller fish. Fish whose migration may be disrupted include least cisco, small Arctic cisco, and large broad whitefish. Dolly varden char are stronger swimmers and more tolerant of saline water. Studies indicate that fish movements have not been impacted by either causeway (Gallaway et al., 1991; Colonell & Gallaway, 1990).

Similar concerns were raised about the Endicott causeway. After extensive studies and debate, a negotiated settlement agreement was reached between the Army Corps of Engineers and industry to breach the causeways thereby providing fish access to the lagoonal migratory corridor, and bring both structures in compliance with state water quality standards (USACE, 1991).

Due to the variability in oceanographic characteristics from year to year, a multi-year monitoring program would be necessary to accurately determine pre versus post-construction effects. A multi-year pre-construction baseline sampling program plus a multi-year post-construction program are necessary to document any adverse effects on fish (Winters, 1996). Some causeway designs could enhance marine productivity and facilitate propagation of fish species. Several years of oceanography studies and fish sampling have been conducted in Mikkelsen Bay, where a causeway or dock has been planned for the Badami

Development Project. No other causeway-type gravel structures are currently for developing nearshore Beaufort reserves.

Despite extensive research into their effects, evidence that the two causeways have had significant population level impacts on anadromous fish remains inconclusive. Some analysts are convinced that impacts of causeways significantly affect fish abundance, and attribute population declines in rivers to Endicott or West Dock, while others are not. Fish abundance and presence in the region in a given year may be influenced by larger forces, such as mesoscale wind phenomena and recruitment success in natal streams. Regardless of the conclusiveness about effects of the Endicott and West Dock causeways, individual fish throughout repeated migrations in their life cycle are likely to be stressed by a solid-fill causeway extending into the Beaufort Sea at key locations near barrier islands. Any gravel structure which obstructs the natural migratory corridor near river mouths has the potential to adversely affect anadromous fish. Altering temperature and salinity in nearshore waters may affect the distribution and abundance of organisms upon which fish feed. For these reasons, solid-fill causeways are discouraged, and many designs, although ideal for field development, are unsuitable for the nearshore environment. Additionally, significant alterations of the shoreline or changes to natural temperature and salinity patterns are prohibited.

Oil spills: The shallow nearshore zone of the Beaufort Sea is used extensively by anadromous fish for feeding. If a very large oil spill were to enter into marine waters during the open season it may affect the ability of fish to reach overwintering areas and spawning streams. Adult fish are likely to avoid an oil spill and not suffer great mortality; but larvae, eggs, and juveniles are more vulnerable because they are more sensitive and less mobile. Species with floating eggs, such as Arctic cod, could suffer extensive mortality depending on the extent and amount of oil spilled (MMS, 1996A: IV-B-17). The total number of fish killed depends on the volume of oil discharged, the time of year of the spill, and the prevention, response and preparedness of clean-up efforts.

The deltas of the Colville, Sagavanirktok, and Canning rivers are important habitat for anadromous fishes. Summertime oil spills within river deltas could impact anadromous fish populations. Adult fish are less susceptible to spilled oil and may be able to avoid areas containing spilled oil or dissolved hydrocarbons by swimming upstream. Less motile juveniles in late summer would be near the surface seeking sunlight and warmth. Most anadromous fish migrate downstream to marine waters to feed, and then upstream to spawn. It is not likely that an entire year class would be lost as it migrated in or out of a delta. Furthermore, if a spill affected anadromous river deltas during migration, the spill would likely not affect the entire delta area and, thus, would not affect the entire migration (MMS, 1987: IV-B-16-19).

Seismic activities: Vibroseis is the most widely used method for acquiring seismic data onshore and is limited to the winter season on the North Slope. There may be instances, however, where the use of Vibroseis is not practicable (such as in difficult terrain or if the substrate prevents adequate data collection), and it is necessary to use explosives as an energy source. Generally, using explosives includes the drilling of holes (10 to 50 feet in depth) spaced as close as 100 feet apart and inserting charges (2 to 20 pound charges), and detonating them. Seismic surveys using explosives are conducted in winter, thus it is possible that some terrestrial wildlife (fox, hibernating squirrel) may be exposed to the energy created by the shot blasts. Pressure waves from high explosives, like ammonia nitrate will kill and injure fish, near the explosion (Fink, 1996 citing to Trasky, 1976; Falk and Lawrence, 1973; Hill, 1978). Overpressures 30-40 psi will kill fish with swim bladders, and 3-4 psi will kill juvenile salmonids. Shock waves from explosions can also shock and jar fish eggs at sensitive stages of development (Fink, 1996, citing to Trasky, 1976; Linton et. al., 1985). These types of impacts are mitigated by restricting the use of explosives in open water or in close proximity to fish-bearing lakes and streams.

The chart associated with Mitigation measure 1 (see Chapter Seven), depicting minimum distances from waterbodies for various sizes of explosive charges; represents the minimum distance that explosives can be used without harming fish or eggs, and reflects Alaska Department of Fish and Game Blasting Standards (1991). These standards were generated after a thorough review of literature and represent ADF&G's considered opinion on the maximum allowable blast impact within fish habitat.

The most recent use of explosives for seismic data acquisition was in 1994 near Thetis Island. This was a line to test the Poulter method which consists of charges that are elevated above the surface on stakes. Prior to that, explosives were permitted during seismic surveying in the Barrow gas field in the spring of 1989. A combination Vibroseis/explosives program was conducted in the Kuparuk-West Sak area in the spring of

1987; and, a small program was conducted by ADNR/DGGS in the summer of 1986. ARCO applied for a permit to use explosives for seismic on the Colville Delta in 1995, but that application was withdrawn after a public comment period.

Mitigation Measures.

Title 16 of the Alaska Statutes requires protection of documented anadromous streams from disturbances associated with development. The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories mitigating potential impacts to fish are:

- Habitat Protection -- Lessees may be required to construct ice and/or snow bridges if ice thickness at a crossing is insufficient to protect the streambed and the stream bank. Any removal of water from fishbearing streams, rivers, and natural lakes requires written approval. When a fishbearing waterbody is used as a water source, lessees must use appropriate measures to avoid entrainment of fish (prevent fish from being drawn into the intake pipe). Lessees must locate, develop, and rehabilitate gravel mine sites in accordance with ADF&G guidelines. Disposal of wastewater, such as domestic greywater, into fresh waterbodies is prohibited.
- Production Discharges -- Unless authorized by NPDES or state permit, disposal of wastewater into freshwater bodies, including Class III, IV, VI, and VIII wetlands, is prohibited. Surface discharge of reserve pit fluids will be prohibited unless authorized by ADEC permit and approved by DL. Disposal of produced waters in upland areas, including wetlands, will be by subsurface disposal techniques.
- Stream Buffers -- Onshore facilities other than roads, docks, and airstrips must not be sited within 500 feet of all fishbearing streams and lakes. Facilities may not be sited within 1/2 mile of the Colville, Canning and Sagavanirktok, Kavik, Shaviovik, Kadleroshilik, Echooka, Ivishak, Kuparuk, Toolik, Anaktuvuk and Chandler Rivers. Facilities will be not be sited within 500 feet of all other fishbearing waterbodies. Additionally, facilities may not be sited within one-half mile of identified Dolly Varden both overwintering/spawning areas on the Kavik, Canning and Shaviovik Rivers. Road and pipeline crossings must be perpendicular to watercourses to prevent buffer erosion.
- Obstructions to Migration and Movement --Continuous fill causeways are discouraged. Causeways, docks or other structures must be designed, sited, and constructed so as to maintain free passage of marine and anadromous fish, and shall not cause significant changes to nearshore oceanographic circulation patterns and water quality characteristics. Causeways may not be located in river mouths or deltas. Activities that may block fish passage in anadromous streams are prohibited. Alteration of river banks, except for approved crossings is prohibited. Operation of equipment other than boats in open water areas of rivers and streams is prohibited. If bridges are not feasible, culverts used for stream crossings must be designed, installed, and maintained to provide efficient passage for fish.
- Protection from Seismic Activities -- Lessees must follow requirements for the use of explosives during onshore seismic activities.
- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, preparedness, response capability, and cleanup of oil spills. Lining and diking of oil or fuel storage tanks is mandatory, and buffer zones are required to separate oil storage facilities from marine and freshwater supplies.

b. Birds

As described in Chapter Three, the Arctic coastal plain's abundant wetlands attract large numbers of important migratory waterbirds each year. Over the years there have been many studies on the effects of North Slope and Beaufort Sea oil and gas development on birds. The results and interpretation of these studies vary.

Some nesting, molting, and staging bird species are sensitive to activities associated with development. Generally, responses to industrial activities depend on species exposed, the physiological or reproductive state of the birds; distance from the disturbance; type, intensity, and duration of the disturbance; and possibly other factors (MMS, 1996: IV-B-21). Potential impacts are more likely to occur after the exploration phase, as few resident species are present during winter when exploration occurs. Potential impacts include: habitat loss, barrier to movement, disturbance during nesting and brooding, change in food abundance and availability, and oil spills.

Habitat loss: Siting of onshore facilities such as drill pads, roads, airfields, pipelines, housing, oil storage facilities, and other infrastructure could eliminate or alter some preferred bird habitats such as wetlands. Onshore pipeline corridors may include a road and associated impacts from traffic, noise and dust may deter nesting in the immediate vicinity. The construction of offshore pipelines or re-supply activities could have temporary effects on the availability of food sources of some birds within a mile or two of the construction area due to turbidity and removal of prey organisms along the pipeline route. Impacts to waterfowl and shorebird populations are not likely to persist after development phase activities are completed (MMS, 1996b: IV-B-23).

After facilities are built, some birds (individuals) can no longer nest in areas because these areas are covered by the new facility. Additional birds may avoid the areas adjacent to the facility due to disturbance effects. However, these habitat changes did not translate into reduced numbers of birds in the area, as the displaced birds were found nesting in nearby areas and returned at rates similar to unaffected birds. There is no indication that displaced birds settled in habitat inferior to that from which they were displaced because they did not incur disproportionately lower nest success at their new nest sites. Habitat availability does not limit most bird populations at Prudhoe Bay. Nest predation by Arctic foxes is proposed as the factor most likely limiting population levels (TERA, 1990:35). The USF&WS disputes this conclusion, citing the small sample size (only one marked bird lost its nest site, and an additional seven had nest sites that were physically altered in some way). They note, however, the results lend no support to the hypothesis of habitat limitation (Sousa, 1997).

A five-year monitoring program to assess the effects of construction and operation of the Lisburne Oil Field on White-fronted Geese, Brant, Snow Geese, and Tundra Swans was conducted from 1985-1990. The purpose was to determine whether development-related disturbance and habitat loss have caused changes in the extent and nature of use of the Lisburne development area by geese and swans. The study concluded that the Lisburne development did not change the extent or nature of use of the area by geese and swans during construction and the first three years of operation of the oil field (Murphy and Anderson, 1993:156). This study synthesized the results from pre-construction studies conducted in 1983 and 1984. The pre-construction studies, however, did not investigate all aspects of goose and swan ecology and therefore a complete comparison with pre-development results was not possible (Murphy and Anderson, 1993:1).

Barriers to movement: Black brant populations have experienced periodic nesting failures in the Sagavanirktok and Kuparuk River deltas (Ott 1993). Adults and young are flightless during the brood-rearing period, so roads, causeways, and other related structures may be barriers to brant movements (Sousa, 1992). There is no evidence that the Endicott road/causeway has been an obstruction to black brant movements (Johnson, 1994:11).

An initial concern expressed before construction began was that the Endicott road/causeway would act as a barrier to the movements of brood-rearing flocks of snow geese as they dispersed eastward from Howe Island after hatching in early July. Overall, 14 years of data show no indication that the Endicott development has impeded eastward movements of snow geese from their nesting colony on Howe Island. This result, and the fact that the snow goose population continues to grow at a rate of almost 30 nesting females per year, indicate no significant population level effects of oil development on the Howe Island snow geese (Johnson, 1994a:29-30). However, other studies document abandonment of brood-rearing areas near the Endicott Road, and unsuccessful crossing attempts and failure of crossing the road for periods up to two weeks (Ott, 1997, citing to Envirosphere Co., 1986). Many negative behavioral reactions to the road/pipeline corridor were noted, although no population effect was detected (Sousa, 1997).

Disturbance: Human activities such as air traffic and foot traffic near nesting waterfowl, shorebirds, and seabirds, could cause some species to temporarily abandon important nesting, feeding and staging areas. Birds have keen eyesight, and even slight movements may cause adults to abandon young hatchlings. A study of effects of aircraft on molting brant in the Teshekpuk Lake area (Derksen et al. 1992) concludes that helicopters (and to a lesser extent, fixed wing aircraft) cause serious disturbance. However, as pointed out in the Habitat Loss section, disturbance does not translate into a population reduction. Some species such as tundra swans, are particularly sensitive to humans on foot, and may abandon their nests when humans approach within 500 to 2000 m of the nest (MMS, 1996b: IV-B-21).

A study of the Gas Handling Expansion Project (GHX-1) to determine the potential effect of gas-compressor turbine noise on waterbird populations, particularly nesting Canada geese and brood-rearing brant, concluded that noise from the GHX-1 facility made only a small contribution to the total noise around the Central Compressor Plant and the Central Gas Facility and had little effect on the use of the study area by waterbirds (Anderson et al. 1992:110).

Research has indicated that some birds may not be readily disturbed. A 1993 study, *Bird Use of the Prudhoe Bay Oil field*, concluded that on the order of 5 percent of the birds in the Prudhoe Bay oil field may have been displaced by gravel placement and secondary alterations of adjacent areas, but that these birds most likely occupy nearby areas. Overall there is rearrangement of birds but probably no net change in bird abundance within the oil field (TERA, 1993:48). The nesting of most local birds is widely dispersed over the coastal tundra and disturbance probably would have little effect on North Slope bird populations as a whole (MMS, 1996b: IV-B-21).

In 1985, ARCO Alaska, Inc., initiated a five-year monitoring program to assess the effects of construction and operation of the Lisburne Oil Field on Canada Geese, Greater White-fronted Geese, Snow Geese and Tundra Swans. Pre-construction studies were conducted in 1983 and 1984, however they did not investigate all aspects of goose and swan ecology evaluated during construction and post-construction. In addition, the Lisburne Field is located within the existing Prudhoe Bay oil field, where oil development activities have been ongoing since the early 1970s. The study encompassed the construction phase (1985-1986) and the first three years of operation (1987-1989). The final synthesis report concluded that the Lisburne development did not change the extent or nature of use of the development area by geese and swans during construction during the first three years of operation. No major shifts in the use of the study area were detected when comparing survey results between construction and post construction and the limited data on bird distribution from pre-development studies (ABR, 1993:156).

In 1983, Sohio Alaska stockpiled over one million cubic meters of gravel on the western tip of Thetis Island. Operations also involved the installation of a temporary support camp, construction of helicopter landing pad, gravel berms to support two large conveyor belts and a fleet of barges to haul the gravel. Sohio instituted a series of mitigation measures—the establishment of an aircraft flight corridor and buffer zone, a restricted access zone for camp personnel, and at the request of USF&WS, a program to remove arctic foxes. The numbers of common eiders nesting on Thetis Island in 1983 were higher than had been recorded in any previous year. The mitigation program implemented by Sohio may have been at least partly responsible for the increase. Three eiders established nests and successfully incubated and hatched eggs at different sites within 300 m of the helicopter landing pad (LGL Associates, 1984:50-54).

Oil Spills: Direct contact with spilled oil by birds is usually fatal, causing death from hypothermia, shock, or drowning. Oil ingestion from preening oily feathers or consumption of oil-contaminated foods may reduce reproductive ability, and could lead to chronic toxicity through the accumulation of hydrocarbon residues. Oil contamination of eggs by oiled feathers of parent birds significantly reduces egg hatching through toxic effects on chick embryo or abandonment of the nest by parent birds (MMS 1996: IV-B-19). The presence of humans, aircraft, boat and vehicular traffic involved in cleanup activities is expected to cause displacement of nesting, molting, and feeding birds in the oiled areas and contribute to reduced reproductive success of the birds (MMS 1996: IV-B-23). The number of birds impacted by a spill would depend on the time of year and the density of local bird populations. Spill prevention and response are described in Chapter Six, and would apply to any new development in Sale 87.

Gas Blowouts: In the event of a natural gas explosion and fire, birds in the immediate vicinity could be killed. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect birds or their food sources except those very near to the source of the blowout (MMS, 1996b: IV.L.2).

Mitigation Measures.

The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to birds are:

- Habitat Protection -- Lessees must identify and avoid sensitive habitat areas and site permanent facilities outside of identified brant, white-fronted goose, snow goose, tundra swan, king eider, common eider, Steller's eider, spectacled eider, and yellow-billed loon nesting and brood rearing areas. Permanent facilities must be sited minimum distances from stream and lakes. Lessees must comply with the USF&WS' recommended protection measures for Spectacled eiders during the nesting and brood rearing periods. Lessees are advised to consider identified sensitive bird habitats when planning operations.

- Disturbance -- Lessees are advised that aircraft must avoid identified brant, white-fronted goose, tundra swan, king eider, common eider, and yellow-billed loon nesting and brood rearing habitat, and the fall staging areas for geese, tundra swans, and shorebirds, during critical time periods in summer and fall. NSB Municipal Code requires that vehicles, vessels, and aircraft that are likely to cause significant disturbance must avoid areas where sensitive species are concentrated. Horizontal and vertical buffers will be required where appropriate under local code (19.70.050(I)(1)).
- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Lining, diking and buffer zones are required to separate oil storage facilities from marine and freshwater supplies.

If oil development occurs, some alteration of bird habitat can be expected. However, with state and federal government oversight, any activities within the Sale 87 area should not prevent overall bird population levels from remaining at or near current levels.

c. Caribou

Since 1975, both government and industry have conducted research on caribou biology and on various aspects of their interaction with North Slope oil and gas developments. Population characteristics (calf production and survival, and adult mortality), habitat use, movement and distribution, and behavioral responses of caribou to oil and gas developments have been studied, but there is disagreement regarding the interpretation of data with respect to the effects of oil and gas development. Some researchers attribute declines in caribou populations to oil and gas development, while others think populations (reproduction and viability) are subject to natural cycles in the ability of the land to support large numbers of caribou (carrying capacity). Still others think caribou numbers are influenced by many factors, such as disease, nutrition, predator abundance (including insects), and weather. Hunting pressure and loss of high quality tundra from oil and gas development is not a primary factor in the rise and fall of sale area caribou populations. Nonetheless, studies show that local distribution and behavior of caribou is affected by infrastructure and human activities within producing oil fields.

Potential impacts can occur at all phases, but most are likely to occur during development and production. Adverse effects are discussed below. Potential effects to caribou populations from Sale 87 include displacement from insect relief and calving areas due to construction and operations, and from oil spills.

Disturbance: One source of disturbance to caribou is construction. During construction, small groups of caribou may be temporarily displaced, but the disturbance reaction would diminish after construction is compete. Furthermore, construction will not take place over the entire sale area at the same time. If caribou are displaced from calving in a certain area due to construction, they are likely to calve in an area where construction is not taking place. The use of specific calving sites within the broad calving area varies from year to year. One local resident has testified that there is no core calving area, and that pregnant females will birth their calves wherever they are when its time (MMS, 1996b:V-142). If calving caribou are displaced from high nutrition forage near a drill site or facility, they are likely to seek any protective area regardless of the forage. The cumulative effect of displacement from high value tundra could be lower calf survival. On the other hand, high populations would force the caribou into lower nutrition areas anyway (MMS, 1996b: IV-B-50).

Cow and calf groups are most sensitive to human disturbance just prior to calving, and during the post calving period (Cronin et al., 1994:11). Caribou may use portions of the coastal plain for calving, but most calves are born in the uplands (USF&WS, 1987:24). Ground-vehicle traffic, aircraft, and human presence near cows with newborn calves also affects individuals as they migrate (MMS, 1996b: IV-B-50). According to ADF&G, caribou, particularly during calving, may be more affected by oil development than previously thought (Smith and Cameron 1991).

Motor-vehicle and aircraft traffic can also disturb caribou. Caribou can be briefly disturbed by low-flying aircraft. The response of caribou to potential disturbance is highly variable--from no reaction to violent escape reactions. Reactions depend on their distance from human activity; speed of approaching disturbance source (altitude of aircraft) and frequency of disturbance; sex, age and physical condition of the animals; size of caribou group; and season, terrain, and weather. Habituation to aircraft and vehicle traffic, and other human activities has been reported in several studies of hoofed-mammal populations in North America. The variability and instability of Arctic ecosystems dictate that caribou have the ability to adapt behaviorally to some environmental changes (MMS, 1996b: IV-B-50).

Aerial surveys of radio-collared females conducted between 1978 and 1987 indicate that parturient females can be displaced by road systems (Cameron, et al., 1992). After construction of the Milne Point road, caribou were significantly less numerous within 1 kilometer of roads and significantly more numerous 5 to 6 kilometers from roads. In addition to the locally perturbed distribution of caribou, researchers observed a decline in relative use of a portion of the study area between Olitok Point and Milne Point roads. However, the causes of reduced use of oil field tundra by calving caribou of the Central Arctic Herd (CAH) is difficult to determine by aerial observations, because of unpredictable random factors, such as weather. “Annual variation in the numbers of caribou observed near Milne Point is primarily an effect of spring snow conditions.” (Cameron, et al., 1992:340) Distribution of caribou tends to be skewed inland in years of late snow melt, and concentrated near the coast in years of early melt. In addition to snow conditions and resultant forage availability, relative occurrence of caribou in the Kuparuk River calving area is influenced by predator and insect avoidance behavior. Overall caribou use of an area could be greatly reduced if roads with moderate traffic are routed too closely (Cameron, et al., 1992). “And inaccessible habitat is habitat lost.” (Cameron, et al., 1995).

Recent findings of Cameron and Ver Hoef (1996) indicate a trend toward reduced calving activity in the Kuparuk development area compared to the undeveloped area to the east of the Sagavanirktok River. This disparity of use east and west of the Sagavanirktok River may be more pronounced in years of early snow melt, when caribou distribution tends to concentrate near the coastline (Cameron and Ver Hoef, 1996). While some researchers point to the presence of oil field road and associated traffic as a factor contributing to a decline in calving success (Cameron, et al., 1995), recent survey data do not support this claim. A survey of caribou in the Kuparuk oil field during the 1996 calving season indicates that the ratio of calves to cows was the highest recorded since 1985, and was near the maximum recorded for the CAH since calving surveys began in 1978 (Lawhead, et al., 1997).

In the absence of insect harassment, caribou within 1,640 feet of roads with no traffic spent more time feeding than did caribou 1,640 feet and farther from roads with traffic. Avoidance of roads during periods of high traffic in the post calving period was noted by Roby in 1978 and by Dau and Cameron in 1986. Some research has indicated that roads which receive little use by humans need not be separated from pipelines (Curatolo and Reges 1985:35). Pipelines elevated at least five feet allow for effective crossing except when they were in proximity to roads with moderate to heavy traffic (15 or more vehicles/hour). The Alaska Caribou Steering Committee concludes the most effective mitigation is achieved when pipelines and roads are separated by at least 500 feet (Cronin et al., 1994:10). Lessees are encouraged in planning and design activities to consider the recommendations for oil field design and operations contained in the final report of the Alaska Caribou Steering Committee.

Disturbance of caribou associated with cumulative oil exploration (particularly by helicopter traffic) is expected to have minor effects on caribou (particularly large groups) with animals being briefly displaced from feeding and resting areas when aircraft pass nearby. Vehicle traffic associated with transportation corridors has the potential to affect habitat use in intensely developed areas of the Prudhoe Bay and Kuparuk oil fields. Acute disturbance effects may in combination result in a cumulative effect on habitat availability for those individuals with fidelity to the Kuparuk River calving area, but may have little or no effect on the CAH population. Despite the fact that cumulative effects at the population level are difficult to quantify, measures should be incorporated into operations planning and facility design to avoid both direct and indirect impacts to caribou.

Habitat Loss and Displacement: Direct habitat loss will result from construction of well pads, pipelines, roads, airfields, processing facilities, housing and other infrastructure. Caribou are subject to mosquito harassment from mid-to-late June through July, and to oestrid fly harassment from mid-July to late August. In response, caribou move from inland feeding areas to windswept, vegetation-free coastal areas where the insects are limited. Most mosquito relief areas are found within 4.5 miles of the coast (ADF&G 1986b:67). Caribou use various coastal habitats such as sandbars, spits, river deltas, and some barrier islands for relief from insect pests. (MMS, 1987: III-33). Caribou may use some of the barrier islands and adjacent areas for insect relief. If coastal habitat is unavailable for insect relief, caribou may use foothills south of the Coastal Plain for insect relief (USF&WS, 1987:123). Insect relief zones not only include coastal areas, but mountain tops, river deltas, flood plains, and river bars.

In the absence of available insect-relief habitat, caribou gather into large groups or continue to move into the wind without feeding. A period of extensive insect harassment can result in weight loss. In addition, caribou lose blood (up to 125 grams/day) to mosquitoes and suffer increased parasitism from skin warbles and nasal bot flies. If caribou are delayed or prevented from free access to insect-relief habitat, the result may be deterioration in body condition resulting in decreased growth, increased winter mortality, and lowered herd productivity (USF&WS, 1987:122).

The frequency and duration of caribou movements to and from the coast depend on weather related changes in the number of mosquitoes, and caribou distribution on the coastal plain can change dramatically within a 24-hour period. Feeding opportunities are limited in windswept insect relief areas, so caribou move inland to better foraging areas whenever insect harassment temporarily subsides, and return to the coast when harassment increases (Shideler, 1986:12). Caribou that remain inland may move to river bars and bluffs to escape insects.

Above-ground pipelines can restrict caribou movement and deter them from seeking preferred habitat unless provisions are made to allow for their free passage. Biologists representing both industry and ADF&G have agreed that facilities built earlier in the development of the Prudhoe Bay oil field have created impediments to caribou movements. Flow and gathering pipelines were elevated only 1 to 4 feet above the surface, thus forming an effective barrier to caribou crossing. However, extensive research on the response of caribou to development has now shown that for many situations it is possible to design facilities so that caribou movements are not significantly impeded. For example, in the Kuparuk development area, elevating pipelines five feet and separating pipelines from roads with traffic have allowed caribou to move with ease through the oil field. Factors influencing the crossing success of caribou beneath elevated pipelines include group size or composition, topography, insect activity, traffic levels, the intensity of local construction, as well as road or pipeline configuration (Shideler 1986). Studies confirm that large numbers of caribou consistently traverse the area during their normal coastward or inland movements in response to insect harassment (Lawhead 1984:8-13).

Crossing success was observed as significantly higher during oestrid fly season than during the mosquito period (Smith and Cameron, undated: 43). The crossing of pipeline corridors occurred more frequently during the insect season than before the onset of insect harassment. Some deflections occurred, but all groups eventually crossed. The incidence of deflection was highest for smaller cow or calf groups at corridors in which pipelines were less than 328 feet from roads. Success tended to be higher at roads or pads without pipelines than at corridors with pipelines. Crossings of up to eight corridors were observed, although no successful crossings occurred with more than ten adjacent pipelines. The groups that crossed more than two pipelines were small (Johnson and Lawhead 1989:i-v, 34-68).

Large groups of caribou tended to split and detour around drill site pads during mosquito induced movements. However, during the oestrid fly harassment season, the caribou were attracted to pipelines, roads, and structures on pads, which presumably provided relief from insect harassment (Johnson and Lawhead 1989).

If displacement from coastal insect-relief areas did occur during the construction of oil and gas facilities, it would be temporary and disturbance reaction would diminish after construction is complete, provided that road systems are not spaced too closely. Routes that caribou take as they migrate to and from the coast depend on their location at the beginning and end of the insect harassment season, and thus as weather phenomena are random, so are the resultant caribou movements (Cameron, et al., 1995). Whereas, calving caribou are highly sensitive to development, "female caribou will tolerate considerable surface development in summer, especially when passage under (or over) pipelines is possible." (Cameron et al., 1995, citing to Smith et al., 1994)

The CAH has grown considerably during the period of oil field development, but lack of pre-development data makes assessment of effects of oil field development difficult. Also, the understanding of the population dynamics of the North Slope caribou herds is incomplete and no firm conclusions about the effects of oil field development on reproductive success of the herd can be drawn. Based upon comparisons with other herds, there have been no apparent effects of oil field development on the growth of CAH. This does not suggest that there may not be effects in the future, or that other herds under different ecological conditions may not be affected (Cronin et al., 1994:3).

Post-sale activities have the potential to affect caribou of the CAH, Teshekpuk Caribou Herd (TCH), and the Porcupine Caribou Herd (PCH). While the summer range of the TCH is outside of the sale area to the west of the Colville River, caribou of the herd may pass through the sale area during their annual migration from the Brooks Range (Philo, et al., 1993). Caribou of the CAH migrate in a north-south direction along major river corridors of the sale area and thus could be affected year-round by oil and gas activities. Caribou of the PCH also can be found year-round in the far eastern portion of the sale area, although winter and summer populations are concentrated in the Arctic National Wildlife Refuge, and in Canada (Cronin, et al., 1994).

"Although new development within existing oil fields may increase cumulative effects, new technologies can reduce the infrastructure surface area (see figure 5.2). The use of directional drilling to maximize the number of wells at drill sites, the centralization of power plants and utility systems, and the joint use of roads, pipeline corridors, and airports all contribute to less area impacted by oil field infrastructure" (Cronin, 1994:7 citing to Senner, 1989).

Documenting positive effects of oil field development is as equally challenging as documenting adverse effects. Dust settling alongside roads in the spring leads to earlier snow melt and green-up of vegetation. Caribou may feed in these areas in late May prior to calving (Cronin, et al., 1994:7, citing to Lawhead and Cameron, 1988). Caribou commonly congregate on gravel pads and roads, and in areas shaded by facilities, possibly for insect relief, particularly from oestrid flies (Cronin, et al., 1994, citing to Johnson and Lawhead, 1989; Lawhead 1990). Caribou were observed using roads and gravel pads and the shade of pipelines and buildings as insect relief areas, which at other times they tended to avoid. Caribou were also observed using unvegetated gravel pads at more than twice the average number of those using vegetated pads of comparable size (BPX, 1990:10). Caribou have habituated to onshore facilities and have been observed using roads, gravel pads, and the shade provided by pipelines and buildings, for insect relief (USF&WS, 1987:122). However, researchers have noted that use of existing oil field facilities as insect relief habitat may cause caribou to avoid preferred foraging areas thought to be further inland (Cronin et al., 1994:7 citing to Roby, 1978).

Measures can be taken in oil field facility design to reduce the potential for adverse effects on caribou, such as displacement. If pipelines must be elevated, they should be so at least 5 feet above the tundra. Where possible, sections of pipeline could be buried, especially at key migration corridors, such as river and stream crossings. There is a correlation between crossing success and the presence and use of an adjacent road. Adverse effects caused by roads with heavy traffic adjacent to pipelines can be mitigated by increasing the distance between the road and the pipeline, and by restricting traffic flow. Roads should be separated from elevated pipelines by at least 500 feet. Installing ramps to facilitate crossings is another option, however studies indicate the effectiveness of ramps is debatable. Ramps are not likely to play a significant role in facilitating direct and undelayed road and pipeline crossings, but may be important facilitators during large scale post-calving movements. Construction and re-supply activities should be scheduled to not occur during calving periods or when significant caribou movements are anticipated. Other measures include horizontal and vertical aircraft flight restrictions; restricting unnecessary public access to the oil field road system; training of oil field employees; and caribou migration monitoring. Biologists should be included in initial field design and in making decisions regarding the placement of facilities and routing of roads and pipelines in key areas (Cronin, et al., 1994:9-14). Finally, to reduce the potential for adverse effects on caribou from direct habitat loss, facility pad size should be minimized. When possible, facilities such as processing units, drill pads, and airstrips should be consolidated. Multiple wells should be drilled from a single surface location when possible, and the use of extended reach drilling techniques should be employed where feasible.

Oil spills: Caribou may also be impacted by oil spills. Caribou that become oiled could die from toxic-hydrocarbon inhalation and absorption through the skin. If caribou were to ingest oil-contaminated vegetation, the result would be significant weight loss and aspiration pneumonia, leading to death. In the event of an oil spill that contaminated tundra or coastal habitats, however, caribou probably would not ingest the oiled vegetation. They are selective grazers that are particular about the plants they consume (MMS, 1996b: IV-B-15). Most likely any impact would be the result of the presence of humans and boat, vehicle, and aircraft traffic operating in the spill area during cleanup operations. Such activity is expected to cause disturbance and displacement of caribou. (MMS, 1996b: IV-B-52).

Gas Blowouts: Impacts of a gas blowout on caribou would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, caribou in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site. It is therefore, not likely that toxic fumes would affect animals except those very near the source of the blowout.

Mitigation Measures.

The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to caribou are:

- Disturbance -- If development occurs, pipelines must be designed and constructed to accommodate caribou movement and migration patterns. Above-ground pipelines must be elevated a minimum of five feet. Ramps or pipeline burial may be required to facilitate caribou movement.
- Habitat Loss -- Lessees are advised that aircraft should avoid caribou concentrations to ensure access to insect relief and calving habitat. Lessees must avoid siting facilities in sensitive habitats and wetlands. Gravel mining must be limited to the minimum necessary to develop a field efficiently.
- Lessees are advised in planning and design activities to consider the recommendations for oil field design and operations contained in the final report to the Alaska Caribou Steering Committee.

Other necessary measures can be imposed if and when lessees apply for the required permits to develop the leases. Moreover, the state has retained the right to cancel the Sale 87 leases if it is determined that continued operations will cause serious harm or damage to the biological resources, to property, or the environment.

d. Muskoxen and Moose

Muskoxen are present in low numbers in the Sagavanirktok drainage and other drainages west of the Canning River and are expanding their range. Little is known regarding the influence of roads, traffic, and pipelines on muskox movements (Ott, 1996).

Moose occur all across the North Slope with the largest concentration along the Colville River and its tributaries. Moose generally remain in the foothill portions of the sale area along river corridors. Post-sale activities are expected to have little effect on the North Slope moose population.

Habitat Loss: Direct habitat loss will result from construction of well pads, pipelines, roads, airfields, processing facilities, housing and other infrastructure (Ott, 1996). Muskoxen have a high fidelity to particular habitat areas because of factors favorable to herd productivity and survival such as food availability, snow conditions, or absence of predators. Displacement from preferred habitat could have a negative effect on muskoxen populations. The magnitude of the effect is difficult to predict, but would likely be related to the magnitude and duration of the displacement. However, given the expanding population and the muskoxen limited use of the sale area, oil and gas development is unlikely to affect muskoxen (USF&WS, 1987:126).

Moose prefer riparian habitat; stands of willow and brush. Very little if any of this habitat is expected to be lost as a result of post-sale activities because of Mitigation measures 16 and 21. Measure 16 prohibits alteration of river banks, except for approved permanent crossings, and except for approved stream crossings, equipment must not be operated within willow stands (Salix spp.). Mitigation measure 21 prohibits permanent facility siting within ½-mile of major rivers in the sale area, including the Colville.

Disturbance: Muskoxen and moose may be subject to disturbance from oil and gas activity. Primary sources of disturbance include seismic activity, vehicle traffic, and aircraft. Muskoxen remain relatively sedentary in the winter, possibly to conserve energy. The energetic costs associated with forced movements during winter may be as significant an impact as disturbance during calving. Mixed groups of muskoxen showed a greater sensitivity to fixed-wing aircraft in winter and during calving than in summer, fall, or during rut. Increased activity during exploration and development in muskoxen overwintering areas may have an adverse effect on muskoxen survival (Sousa, 1992). Muskoxen may be able to habituate to aircraft and seismic disturbance (USF&WS, 1987:124).

Moose adapt readily and habituate to the presence of human activity and are not easily disturbed (USF&WS, 1987:126, citing to Denniston, 1956; and Peterson, 1955). However, they can become agitated and may be more sensitive to disturbance when calves are present from mid-May to early June. On the Kenai National Wildlife Refuge, moose distribution, movements or behavior were not affected by helicopter-supported winter seismic surveys using explosives (USF&WS, 1987:126, citing to Bangs and Bailey, 1982). Moose generally do not venture as far north as the existing oil fields, however in the southern portion of the sale area, some moose-oil field interaction may become common. Some fencing may be appropriate around facilities. Moose mortality may occur as a result of collisions with vehicles (USF&WS, 1987:126).

Oil Spills: In general the effects of an oil spill on muskoxen and moose would be similar to that of other terrestrial mammals. An oil spill may result in oil contamination of individual mammals, in the immediate vicinity, contamination of habitats, and contamination of some local food sources. In the event of a large oil spill contacting and extensively oiling habitats with concentrations of muskoxen or moose, the presence of humans and traffic from vehicles and aircraft are expected to cause disturbance and displacement of muskoxen during cleanup operations.

Gas Blowouts: Impacts on muskoxen and moose of a gas blowout would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, muskoxen in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout.

Mitigation Measures.

For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Potential impacts to muskoxen and moose would be mitigated by the following:

- Disturbance -- If development occurs, pipelines must be designed and constructed to accommodate muskoxen movement and migration patterns. Lessees are advised that aircraft should avoid muskoxen concentrations.
- Alteration of river banks, except for approved permanent crossings, will be prohibited. Except for approved stream crossings, equipment must not be operated within willow stands (Salix spp.).
- To the extent feasible and prudent, facilities will not be sited within 1/2 mile of the banks of the Colville, Canning, Kavik, Shaviovik, Kadleroshilik, Sagavanirktok and Kuparuk Rivers.

e. Brown Bear

Brown bears can be found throughout the Arctic region in varying densities. The lowest densities occur along the coastal plain. In the Arctic, brown bears are at the northern limits of their range. The availability of food is limited and their reproductive potential is low (ADF&G, 1986a:41).

Habitat Loss: Direct habitat loss will result from construction of well pads, pipelines, roads, airfields, processing facilities, housing and other infrastructure. Quantifying the number of animals involved is difficult. Brown bears travel along the major river corridors and feed in riparian areas of the sale area. Siting facilities outside these areas will reduce potential impacts on brown bears (USF&WS, 1987:128).

Disturbance: Brown bears may be subject to disturbance from oil and gas activity. Primary sources of disturbance include seismic activity, vehicle traffic, and aircraft. Seismic activity which occurs in winter may disturb denning bears. Studies have found that radio-collared bears in their dens were disturbed by seismic activities within 1.2 miles of their dens and demonstrated by an increased heart rate and greater movement within the den. However, no negative effect, such as den abandonment was documented (USF&WS, 1987:128).

Interaction with Humans: During exploration and development, human activity may attract foraging bears, especially to refuse disposal areas. Omnivores are attracted to food and food odors associated with human activity, and may become conditioned to non-natural food sources (Baker, 1987). This may pose a threat to human safety and the potential need to shoot “problem” animals. Bears can also be displaced by human land use activities.

<u>Oil Spills:</u> The potential effects of oil spills on brown bears include contamination of individual animals, contamination of coastal habitats, and contamination of some local food sources. Bears feed on fish concentrations at overwintering and spawning areas. Bears may also feed on beached marine mammal carcasses along the coast (Ott, 1997). If an oil spill contaminates beaches along the coast, bears are likely to ingest contaminated food sources. In the event of a large oil spill contacting and extensively oiling habitats with concentrations of brown bears, the presence of humans and traffic from vehicles and aircraft are expected to cause disturbance and displacement of brown bears during cleanup operations.

<u>Gas Blowouts</u>: Impacts on brown bear of a gas blowout would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, brown bear in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout.

Mitigation Measures.

The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to brown bear are:

- Waste management -- lessees must use appropriate methods of garbage and putrescible waste disposal to minimize attracting bears.
- Habitat protection -- lessees must avoid conducting exploration or development activities in the vicinity of occupied dens, or obtain approval for alternative mitigating measures.
- Avoidance of human/bear conflicts --- lessees are encouraged to prepare bear interaction plans.

f. Furbearers

<u>Wolves, Wolverines, and Foxes</u>: Fox populations vary in response to fluctuations in their natural prey sources, but a constant food supply could maintain the fox population at artificially high levels. This could cause near total nest failure of all waterfowl and shorebirds in the development area as foxes prey on eggs and young birds. Foxes and wolves, are also noted for their rabies outbreaks, which increase when population densities are high, creating health risks to humans. Activity during exploration and development may attract foraging foxes, and wolves, especially to refuse disposal areas. Wolverines apparently are not attracted to garbage (USF&WS, 1986: 534-537).

<u>Habitat Loss</u>: Winter arctic fox habitat is primarily along the coast and sea ice. Denning occurs up to 15 miles inland. Red foxes also may den within 10 miles of the coast but are generally found farther inland (Ott, 1996). Habitat destruction would primarily affect foxes through destruction of den sites. Placement of oil and gas infrastructure at or near den sites may either destroy den sites or cause foxes to den elsewhere (USF&WS, 1986:533-536). However, foxes have been known to use culverts and other construction materials for denning. Wolverines occur exclusively in remote regions where human activity is unlikely, therefore, displacement of wolverines from local areas of development is likely (USF&WS, 1987:127-128).

The effects of direct habitat loss on wolves would be negligible. The abundance of wolves is ultimately determined by the availability of prey. The ability of adults to provide food is the key determinant in wolf-pup survival. Reduction in prey species, such as caribou, could reduce wolf populations (USF&WS, 1987:126).

<u>Disturbance</u>: Wolves are unlikely to be disturbed by development. Wolves readily habituate to human activity. During construction of the Dalton Highway and TAPS, wolves readily accepted handouts from construction workers (USF&WS, 1987:127). Primary sources of disturbance are seismic activities and aircraft traffic. Helicopters generally invoke a stronger response from wolves and foxes than fixed-wing aircraft. Ice roads connecting well sites and supply areas would provide a source of disturbance from vehicles. Impacts of seismic exploration and drilling on wolverines are unknown (USF&WS, 1986:535).

<u>Oil Spills:</u> The general effects of an oil spill on wolves, wolverines, and foxes are similar to that of other terrestrial animals. The potential effects of oil spills include contamination of individual animals, contamination of habitats, and contamination of some local food sources. Furbearers, particularly foxes, may be attracted to dead oiled wildlife at a spill site. Foxes may be attracted to the human activity at a spill site by the possibility of finding food or garbage. In the event of a large oil spill contacting and extensively oiling habitats with concentrations of wolves, wolverines and foxes, the presence of humans and traffic from vehicles and aircraft are expected to cause disturbance and displacement of these animals during cleanup operations, with the possible exception of foxes.

Gas Blowouts: Impacts on wolves, wolverines, and foxes of a gas blowout would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, animals in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout.

Mitigation Measures.

The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to wolves, wolverines, and foxes are:

- Habitat protection -- Exploration facilities must be temporary and must utilize ice roads and pads. Facilities may not be sited within waterbody buffers utilized by furbearers.
- Waste management -- lessees must use appropriate methods of garbage and putrescible waste disposal to minimize attracting wolves, wolverines, and foxes.

g. Polar Bear

Potential impact to polar bears include disruption of denning, attraction to areas of activity, ingestion of oil, oil contamination, and adverse interaction with humans.

Habitat loss: Construction of offshore oil and gas facilities such as pipelines, gravel islands, causeways, and production platforms are expected to have local effects on ice movements and fast ice formation around the structures. This will likely have a short term (less than one year) affect on polar bear distribution during construction activities (MMS, 1996b: IV-H-13).

Disturbance: The primary sources of noise disturbance would come from air and marine traffic. Seismic activities and low-frequency noise from drilling operations would also be a source of noise. Disturbance from human activities, such as ice road construction and seismic work, may cause pregnant females to abandon dens early. Early abandonment of maternal dens can be fatal to cubs. If some coastal denning areas in and some maternity dens on the sea ice were abandoned because of noise and human presence near denning areas a short-term (one-generation) disturbance effect on polar bears is expected. However, existing requirements under the MMPA are expected to prevent excessive disturbance of the bears (MMS, 1996b: IV-H-13).

Habitat Modification: Polar bears continually search for food. Once bears find a camp or industrial site, they will often enter to explore and search for food. If a bear receives a food reward, it is almost certain to return. They invariably investigate not only things that smell or act like food, but also novel sights or odors. Subadults are more likely to be food-stressed and, therefore, attracted to human activity more commonly than well-fed bears; they also are less likely to leave if a potential food source is present. Attractants include kitchen odors, deliberate feeding, accessible garbage, sewage lagoons, carcasses, industrial materials, and alteration of habitat (MMS, 1993:13).

Oil contamination: Polar bears have been observed eating hydraulic fluid and other petroleum lubricants, and at least one bear in the Prudhoe Bay area died as a result of ingesting ethylene glycol antifreeze (Ott 1990). Polar bears are extremely sensitive to external and internal oil contamination. Bears may contact oil directly by swimming or wallowing in contaminated areas; and indirectly by scavenging oiled carcasses along the beach, by preying on oiled seals, or while maintaining their fur. It is important for polar bears to keep their fur clean to get the maximum benefit from its insulative qualities (MMS, 1993:12). In the event of a large oil spill contacting and extensively oiling coastal habitats with concentrations of polar bears, the presence of humans (boat, vehicle, and aircraft traffic operating in the area) is expected to cause disturbance and displacement of polar bears during cleanup operations. However, polar bears may be attracted to a spill site by the presence of dead birds or other animals killed by the spill, or by the human activity previously associated with a food source (MMS, 1996b: IV-B-26).

Adverse interaction with humans: Some polar bears could be killed as a result of human-bear encounters near industrial sites and settlements associated with oil and gas development. Some of these losses are unavoidable and represent a small source of mortality on the polar bear population that would be replaced by reproduction within one year. The incidental loss of polar bears due to oil and gas development in the sale area is unlikely to significantly increase the mortality rate of the polar bear population above that which is occurring due to subsistence harvests and natural causes (MMS, 1996b: IV-H-13).

Polar bears are protected under the MMPA of 1972 (Act). In Alaska, the protection of polar bears under the Act is the responsibility of USF&WS. The MMPA prohibits the "taking" of marine mammals. By interpretation, taking is said to occur whenever human activity causes a polar bear to change its behavior. Disturbing a polar bear by trying to take a picture of it or scaring a bear away from a building are violations under the law (MMS, 1993:61).

Taking a polar bear by individuals is legal under some circumstances, such as federal, state, or local government officials acting in the course of their official duties. Native Alaskans living on the coast are allowed to hunt polar bears for subsistence and handicraft purposes, provided it is not done in a wasteful manner.

In 1987, the NSB Fish and Game Management Committee and the Inuvialuit Game Council of Canada signed an agreement on polar bear management in the southern Beaufort Sea region. Among other measures, the agreement protects bears in dens and family groups with cubs, sets a hunting season, provides a framework for setting annual quotas for each country, and establishes a reporting system. The agreement is voluntary and has no regulatory backing (MMS, 1993:63).

In 1993, amendments to the MMPA made the USF&WS responsible for the conservation of polar bears in Alaska. These amendments allowed for the incidental, but unintentional "take"[2] of small numbers of polar bears. To comply with the requirements of the "take" regulations, oil and gas activities in Important Habitat Areas in the Beaufort Sea are subject to a Letter of Authorization (LOA) from the USF&WS Regional Director of the Alaska Region. The northern coastal portion of the Sale 87 area has been identified as an Important Habitat Area. The decision to request a LOA is up to the individual operator, although they are liable for incidental takes in the absence of a LOA. LOA's specify terms and conditions appropriate for the conservation of polar bears, such as interaction plans and detection efforts. Through the LOA, USF&WS has the authority to require and specify the type of interaction plans. LOA's are tailored to the individual project and take into consideration factors including the time period and specific location where the activity is to take place.

Bear den and seal lair detection efforts are not required of operators, although these could be imposed at the plan of operations stage. Under terms of Letters of Authorization (LOAs) and Mitigation measure 22b, industry is required to contact USF&WS to compare the locations of known active polar bear dens with industry activities to avoid known dens by one mile, withdraw immediately from any new dens, and report new dens to the USF&WS (USF&WS, 1995:46). Detection methods consist of reconnaissance by snow machine, and aerial surveys. The USGS Biological Survey Division, with assistance from BP and ARCO, is testing forward looking infrared radar. This method, which locates animals by the heat their bodies give off, has successfully detected a 100 watt light bulb placed in a man made den (Schliebe, 1997).

[2] "Take", as defined by the MMPA, means to harass, hunt, capture, or kill or attempt to harass, hunt, capture, or kill any marine mammal. "Harass" is defined to mean any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild; or has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

Mitigation Measures.

The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to polar bears are:

- Disturbance -- Lessees are advised aircraft must avoid areas where species that are sensitive to noise and movement are concentrated.
- Waste management -- lessees must use appropriate methods of garbage and putrescible waste disposal to minimize attracting bears.
- Habitat protection -- lessees must avoid conducting exploration or development activities in the vicinity of occupied dens. Lessees are advised that certain areas are especially valuable for their concentrations of polar bears and must be considered when developing plans of operation.
- Avoidance of human/bear conflicts -- lessees are encouraged to prepare bear interaction plans.
- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Lining, diking and buffer zones are required to separate oil storage facilities from marine and freshwater supplies.

h. Other Marine Mammals

Despite protective measures, Sale 87 could add to cumulative impacts on ringed, spotted and bearded seals, and walrus. The majority of the North Pacific walrus population occurs west of Barrow, although a few walrus may move east throughout the Alaskan portion of the Beaufort Sea to Canadian waters during the open water season. Spring and summertime oil and gas exploration and development activities in the sale area and elsewhere in the Beaufort Sea could disturb seals and walrus and depending on other human activity in the area, could ultimately contribute to some limited displacement. Both species of seals are commonly distributed throughout the coastal portion of the sale area, and populations vary considerably with seasonal weather changes.

Habitat Loss: Some pinnipeds could be temporarily displaced by construction activities associated with causeway construction. Onshore development near the coast could also disturb a small number of pinnipeds. However, the amount of displacement is likely to be very small in comparison with the natural variability in seasonal habitat use and is not expected to affect seal populations. Effects are likely to be one year or season or less with any disturbance of pinnipeds declining after construction activities are complete (MMS, 1996b:IV-B-30).

Disturbance: The primary sources of noise and disturbance of pinnipeds would come from marine traffic, air traffic, and geophysical surveys. A secondary source would be low frequency noises from drilling operations. Boat traffic could disturb some pinnipeds concentrations. However, such traffic is not likely to have more than a short-term (a few hours to a few days) effect. Helicopter traffic is assumed to be a source of disturbance to pinnipeds hauled out along the beaches of the Colville River Delta and other haulout areas. Such brief occasional disturbances are not likely to have any serious consequences. Noise and disturbance from seismic operations could cause a brief disturbance response from seals and walrus. However the affected animals are likely to return to normal behavior patterns within a short period of time (MMS, 1996b:IV-B-29).

Oil Spills: Direct contact with spilled oil by pinnipeds may result in some mortalities. If newborn seal pups come in contact with oil, they may lose their thermo-insulation capabilities and die from hypothermia. Adults may only suffer from temporary eye and skin irritations. The specific effects would depend on many factors, including the seal's age and health. Seals are known to be capable of metabolizing as well as excreting and absorbing oil. In general, deaths from contact with oil among adult seals are most likely to occur during periods of high natural stress such as during the molting season or times of inadequate food supply or if affected by disease (MMS, 1987). The measures outlined above for whales will also protect seals and will reduce the likelihood that oil spills or human activity associated with oil and gas exploration and development activities could adversely affect marine mammals such as ringed seals. In the event of a large oil spill contacting and extensively oiling coastal habitats with concentrations of pinnipeds, boat, vehicle, and aircraft traffic operating in the area is expected to cause disturbance and displacement of pinnipeds during cleanup operations. If operations occurred in the spring they would contribute to increased stress and reduced pup survival of seals (MMS, 1996b:IV-B-26).

Mitigation Measures.

For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to pinnipeds are:

- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Lining, diking and buffer zones are required to separate oil storage facilities from marine and freshwater supplies.

3. Effects on Subsistence Uses

Traditional subsistence uses include bowhead and beluga whaling; walrus, polar bear and seal hunting; brown bear, caribou, musk ox, and moose harvesting; hunting and trapping of furbearers, such as wolf, fox, weasel, wolverine, and squirrel; the taking of migratory waterfowl and their eggs; the fishing of whitefish, char, salmon, smelt, grayling, trout, and burbot; the collection of berries, edible plants, and wood; and the producing of crafts, clothing, and tools made from these wild resources. Subsistence also includes social activities of consuming, sharing, trading and giving, cooperating, teaching and celebration among members of the community.

Direct effects on subsistence uses may include increased access and land use limitations, less privacy, immediate effects of oil spills, and potential increase in wage earning opportunities to supplant subsistence activities. Indirect effects include the potential reduction in local fish and wildlife populations due to development, increased travel distance and hunting time required to harvest resources, potential reductions in harvest success rates, increased competition for nearby subsistence resources, improvements in community transportation, trade, and utilities infrastructure, and increased revenues to local government through petroleum revenue taxes.

Alteration of the physical environment may affect migration, nesting, breeding, calving, denning and staging of animals which are sensitive to oil and gas development activities. For example, noise propagation from jet aircraft is known to affect the behavior of molting waterbirds. Above-ground pipelines can disrupt annual caribou migrations if not elevated properly or buried. Vehicle traffic may adversely affect foraging caribou by displacing them from preferred forage areas. Such effects can be reduced or avoided by observing mitigation measures which restrict oil and gas activities.

Other physical alterations of the environment from post-sale activity could affect subsistence. If a road adjacent to a pipeline was heavily traveled (as in during a project’s construction phase), caribou may avoid the area of higher vehicle activity. The result could be that a subsistence hunter may have to travel farther from the village in order to capture the affected caribou. Another example might be the industrial use of water, which could affect the drainage pattern of a river distributary, thereby affecting a particular anadromous fish run which happens to be a part of a commercial or subsistence fishery.

Any activity which has the potential to harm fish or wildlife has the potential to affect subsistence. Mitigation measures have been designed to avoid, reduce or minimize biological alterations to the sale area. Reducing impacts to subsistence resources from oil and gas development is a primary goal in lease sale planning. The objective of protecting subsistence uses lies in protecting cultural and biological resources (See previous subsection of this chapter and the following subsection).

The effects of an oil spill on marine mammals and fish is the most feared adverse impact from oil and gas development offshore. Residents are concerned that the technology does not exist to clean up a major spill, which, regardless of the time of year, would not be possible to fully clean up and which would have incalculable effects on subsistence resources. Residents, having witnessed decades of sea-ice activity, continue to question the structural integrity of drill rigs in the face of tremendous ice forces. An older resident observed sea ice suddenly rise up a 20 foot bluff, threatening homes in Barrow (MMS, 1996b:V-141).

Fish, such as Arctic cisco or broad whitefish which utilize portions of the sale area for migration and feeding, could also be affected by excessive disturbances from some oil and gas activities, such as causeways or oil spills. These fish could be directly damaged, or otherwise made less accessible to subsistence fishers. The inability to harvest seals or other marine mammals due to avoidance behavior or loss of supporting habitat could affect subsistence uses other than for food consumption, such as use of seal skins for covering umiaks, or skins and furs for clothing, and handicrafts. Traditional whaling harvests are not expected to be affected by post-sale activities.

Community well-being depends on the continued use of subsistence resources because they are culturally and economically significant. The subsistence way of life, with its associated values of sharing food and its influence on the extended family and traditional knowledge, is considered an integral part of being Inupiat (Kruse and others 1983:185). In addition to this cultural component, subsistence is the direct source of economic well being for NSB residents. Subsistence resources enter into household income as a food source that does not have to be purchased. A loss of subsistence resources would be a loss of income for the entire community (MMS, 1996b:IV-B-57).

Previous subsections of this chapter describe the potential impacts to fish and wildlife populations due to habitat loss, disturbance, oil spills, and gas blowouts. They also discuss the mitigation measures that will be imposed on Sale 87 to maintain fish and wildlife populations. Additional site-specific and project specific mitigation measures may be required later if exploration and development take place.

As new discoveries are made, the number of development-related facilities will increase, and portions of the developed areas could be closed to public access, reducing the area available for subsistence activities. If subsistence hunters are displaced from traditional hunting areas they might have to travel greater distances and spend more time harvesting resources. At the same time, increased public access to hunting, fishing, and trapping areas, due to construction of new roads, could increase competition between user groups for subsistence resources. If competition for scarce resources, like moose, on the North Slope were to increase, game managers would restrict non-subsistence hunting and fishing. Management practices to restrict non-local resident hunting are in place for Game Management Unit 26. See Chapter Four for a description of sport hunting and fishing in the sale area.

Impacts on subsistence usage from oil and gas exploration, development, production, and transportation depend on Sale 87 mitigation measures, operator and lease holder company policies, and all applicable wildlife conservation and protection laws. Additionally, Alaska Air Quality Control regulations may require temporary air exclusion zones around new facilities identified under 18 AAC 50.300. ADEC may require as a condition of permit approval, air exclusion zones around facilities and operations that exceed allowable emissions. Operators may be required by ADEC to restrict public access within 1.5 kilometers of such facilities. All plans of operations proposals (approval of these plans is required before any exploration or development activity can begin) are reviewed for consistency with applicable laws, including the Alaska Coastal Management Program and North Slope Borough Coastal Management Plan (NSBCMP). The entire Sale 87 Area is located within the NSB Coastal Management Zone. The NSBCMP Standards for Development Policy 2.4.3(d) states, “Development shall not preclude reasonable subsistence user access to a subsistence resource.” For a complete review of this sale’s consistency with coastal management plans, see “Alaska Coastal Management Program Consistency Analysis Regarding Proposed Oil and Gas Lease Sale 87, North Slope Areawide.”

ACMP standards are applied at the lease sale stage and they will be reapplied at all future phases. Under 6 AAC 80.120, Coastal Management Districts must identify areas in which subsistence is the dominant use of coastal areas and resources. Under (d) of that section, a study of the possible adverse impacts of the proposed potentially conflicting use or activity upon subsistence usage must be conducted for these designated areas and safeguards must be appropriated to protect the subsistence usage priority. This applies when an activity, use or project is actually proposed.

Subsistence conflict resolution --Prior to initiating any activity that may disrupt subsistence harvesting, lessees must consult with the affected community to discuss potential conflicts before plans of operation are approved. Lessees are advised to consult with the NSB when planning operations and generate potential solutions to problems. The parties must discuss the reasonably foreseeable effect on subsistence activities of any other operations in the area that they know will occur during the lessee’s proposed operations. A discussion of resolutions reached and plans for continued consultation shall be included in the plan of operations. If the parties cannot agree, the commissioner or his representative may assemble them. Lessees are advised that interfering with reasonable access to subsistence resources violates the ACMP and NSB Municipal Code.

Mitigation Measures.

The following are summaries of some applicable mitigation measures. For a complete listof Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to subsistence are:

- Harvest disruption --Copies of seismic permit applications will be made available to the NSB, AEWC, and potentially affected subsistence communities for comment. Lessees are advised that interfering with reasonable access to subsistence resources violates the ACMP and NSB Municipal Code. Aircraft must avoid sensitive bird habitat, and vertical and horizontal buffers separating aircraft from waterfowl, caribou, and muskoxen may be required. Identified sensitive habitats must be avoided and potential adverse impacts considered in operations planning. Lessees must comply with seasonal drilling restrictions in identified subsistence whaling zones, and coordinate activities with local whaling captains..
- Historic and Archaeological Site Preservation -- Lessees must conduct an inventory of traditional use sites in the area proposed for activity and ensure that archaeological resources are preserved. Lessees must include in any development plan, a program to educate oil field workers about community values, customs, lifestyles, and laws protecting cultural resources in the proposed sale area.
- Unrestricted access -- No restriction of public access to, or use of, the proposed lease sale area due to oil and gas activity will be permitted, except within the immediate vicinity of drill sites, buildings and other related facilities. Any area of restricted access must be justified in the plan of operations.
- Oil Spill Prevention and Response -- In addition to addressing the prevention, detection, and cleanup of releases of oil, contingency plans (C-Plans) include methods for detecting, responding to, and controlling blowouts; the location and identification of oil spill cleanup equipment; the location and availability of suitable alternative drilling equipment; a plan of operations to mobilize and drill a relief well.
- Harvest conflict resolution -- lessees must cooperate with agencies and the public to avoid conflicts by selecting alternative sites or implementing seasonal restrictions on certain activities, and by siting permanent facilities a minimum distance from rivers. Prior to initiating any activity which may disrupt subsistence harvesting, lessees must consult with the affected community before plans of operation may be approved. Lessees are advised to consult with the NSB during planning of operations.
- Community participation -- Lessees are advised to bring local residents into their operations planning process. Residents can provide critical input and traditional knowledge to operations and oil spill prevention and response plans. Community representation on management teams facilitate understanding and the transfer of information between the lessee and the residents.

4. Effects on Historic and Cultural Uses.

Cultural and historic resources are those sites and artifacts having significance to the culture of Arctic people. Historic and cultural sites are those identified by the National Register of Historic Sites, and include those identified in the NSB Traditional Land Use Inventory (TLUI), by the Commission on Inupiat History, Language and Culture, and sites identified in other published studies. Many places, such as ancient village locations along the distributaries of the Colville River, which contain archaeologically important relics continue to be used today. Information regarding important cultural and historic sites can be obtained by contacting the North Slope Borough Planning Department. See also Hoffman, et al., (1988), Jacobson and Wentworth (1982), the Nuiqsut Cultural Plan (NSB, 1979b), and the NSBCMP Background Report and Coastal Resource Atlas (NSB 1984:b) and the NSB Municipal Code (NSBMC 19.70.050(E).

Under NSB Land Management Regulations, any proposed development project shall not impact any historic, prehistoric or archaeological resource prior to an assessment of that resource by a professional archaeologist (NSBMC 19.50.030(F)). Additional protection from development disturbance is assured under NSBCMP Policy 2.4.3 to “sites eligible for inclusion in the National Register; or sites identified as important to the study, understanding, or illustration of national, state or local history or prehistory...” Finally, under NSB Land Management Regulation 19.70.050(F), “Development shall not significantly interfere with traditional activities at cultural or historic sites identified in the NSBCMP. These provisions give the NSB significant authority to protect both cultural historic resources, and current subsistence uses of these sites.

Potential impacts could occur in either the exploration, development, or production phases, but are more likely to occur if development occurs. Impacts include disruption of culture and disturbance of historic and archeological sites.

a. Historic use and archeological sites

The Alaska Heritage Resources Survey is an inventory of all reported historic and prehistoric sites within the state of Alaska. This inventory of cultural resources includes objects, structures, buildings, sites, districts, and travelways, with a general provision that they be over 50 years old. By knowing of possible cultural remains prior to construction, efforts can be made to avoid project delays and prevent unnecessary destruction. Listing on the AHRS does not, in and of itself, provide protection for sites.

For each individual site, the Office of History and Archaeology maintains a site record card containing such information as the site name, a description of the physical remains, data on the site's location, and list of bibliographic citations, as well as a variety of additional information relevant to management and research needs. DO&G has researched the available resources and found there are approximately 52 known historic or prehistoric sites in the sale area. There is a high potential for the discovery of additional sites. Carbon dating revealed that one site had artifacts nearly 6,000 years old (DPOR, 1997).

b. Disturbance

Impacts may be caused by surface vehicle traffic, construction activity associated with drill pads, roads, airstrips, pipelines and processing facilities. Damage to archaeological sites can include direct breakage of cultural objects, damage to vegetation and thermal regime leading to erosion and deterioration of organic sites, and shifting or mixing of components in sites resulting in loss of association between objects. Crews at archeological or historic sites could damage or destroy sites by collecting artifacts (USF&WS, 1986:537-539).

Many sites along the coast are currently eroding into the sea. Storm surges during the summer and fall open water season have caused rapid coastline erosion. Sediments are reworked to varying depths by current transport and ice gouging which makes the survival of any prehistoric sites offshore unlikely (MMS, 1996b: III-C-21).

c. Oil Spills

Oil spills can have an indirect effect on archaeological sites by contamination of organic material which would eliminate the possibility of using carbon dating methods (USF&WS, 1986:537). The *Exxon Valdez* oil spill cleanup demonstrated that archaeological resources generally were not directly affected by the spill. The largest effects came from vandalism, because more people knew about the location of the resources and were present at the sites. That knowledge increased as the population and activities increased during the cleanup process (Bittner, 1993).

The detrimental effects of cleanup were slight during the *Exxon Valdez* oil spill because the work plan for cleanup was constantly reviewed, and cleanup techniques were changed as needed to protect archeological and cultural resources (Bittner, 1993).

d. Gas Blowouts

Disturbance to historical and archeological sites might occur as a result of onshore activity associated with accidents such as a gas blowout or explosion. Cleanup after such accidents could result in disturbance by cleanup workers in the vicinity of the accident site. Archaeological resources in the immediate vicinity of the blowout might be destroyed.

"It is the policy of the state to preserve and protect the historic, prehistoric and archeological resources of Alaska from loss, desecration and destruction . . . " AS 41.35.010. Existing statutes, which apply to both known sites and newly discovered sites, are:

- AS 41.35.200(a) prohibits a person from unlawfully appropriating, excavating, removing, injuring or destroying any historic, prehistoric, or archeological resources of the state. "Historic, prehistoric, or archeological resources" include" deposits, structures, ruins, sites, buildings, graves, artifacts, fossils, or other objects of antiquity which provide information pertaining to the historical or prehistoric culture of people in the state as well as to the natural history of the state." AS 41.35.230(2). Violators of this statute are subject to criminal (misdemeanor) penalties and civil penalties (fines up to $100,000 per violation). AS 41.35.210, 215.

- AS 41.35.200(c) prohibits the unlawful destruction, mutilation, defacement, injury to, removal of or excavation of a grave site, tomb, monument, gravestone, or other structure or object at a grave site, even if the grave site appears to be abandoned, lost, or neglected. Violators of this statute are subject to the same penalties listed above for AS 41.35.200(a) [historic, prehistoric and archeological resources].

Mitigation Measures.

The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to historic and cultural uses are:

- Education -- lessees are required to conduct training for all employees and contractors on environmental, social, and cultural concerns in the sale area.
- Protection of historic and archeological sites -- prior to exploration activities involving ground disturbance, and subsequent development, lessees must conduct an archeological inventory. If any objects are discovered at any time, they must be reported, and appropriate protective measures followed.

C. Effects on Municipalities and Communities

The lease sale and subsequent activities may affect municipal governments by shifting spending or planning priorities, increasing or decreasing demand for a public service, or by expanding their functional roles, such as accounting, collecting new taxes, inter-governmental representation, and regulatory oversight. The sale and subsequent activities may also affect people in communities within or near the sale area. Oil and gas exploration, development, production, and transportation may affect patterns of subsistence use, access to village environs, occupations and income, and perceptions of culture.

1. Effects on Municipalities

a. Public Services and Employment

Considering the NSB provides all public services (with the exception of parks and recreation) to Nuiqsut, Kaktovik, and Anaktuvuk Pass, the impact on those city governments is likely to be minimal. However, post-sale activities may require staff time if projects are proposed within city limits, on city property, or within the village’s zone of influence.

If projects are proposed, one or more members of the city council or administrative staff may want to represent the village at meetings. Some planning work, such as reviewing and commenting on documents and project oversight may serve the interests of the community if development were proposed within the village zone of influence. Lessees are advised to include a member of the affected community in their planning process. Some NSB staff may be needed to participate in wildlife studies, peer reviews, or community outreach programs sponsored by lessees if the proposed project has the potential to impact natural resources or local employment levels.

The NSB provides services to residents of the sale area including health care, emergency medical services, public education, electricity, water service, sanitation, housing assistance, and public works. Exploration and development activities require labor and capital-intensive infrastructure. An increased presence of oil field workers may increase demand for a public service, like housing or sanitation, in communities where oil field development services are based, such as Barrow. However, in the sale area, development projects are normally stand alone self-sufficient operations or might be supported by existing infrastructure near Deadhorse, and would therefore place no additional burden on public services.

The communities of Nuiqsut, Kaktovik, Anaktuvuk Pass, and Barrow could provide some labor needs if projects are proposed, approved, and developed. Although unlikely, a very large project coupled with an effective local hire initiative could draw labor away from local government positions for the NSB and village governments. Locally owned and operated oil field support companies may also provide services to lessees or operators. As with the Alpine development project, located near Nuiqsut, local contracts for services, such as gravel, can be made in advance of project approvals.

b. Land Use

The entire Sale 87 area is located within the North Slope Borough. During the pre-exploration phase, applications for seismic and possibly exploratory drilling permits may be submitted to the DO&G and other resource agencies for review. Pre-exploration includes reconnaissance activities related to resource extraction including surface geologic mapping, surveys other than seismic surveys and geologic sampling. This includes samples taken by hand or lightweight equipment that does not penetrate the tundra or submerged lands to a depth of more than 50 feet (NSBMC 19.20.020).

The NSB Resource Development District is a zoned area which encompasses all oil fields that are currently producing. If any activity were proposed on leases located outside the NSB’s Resource Development District, the borough’s Zoning Commission would have to approve the development, and a public hearing would be held. Applicants must provide a Master Plan of development to the NSB Zoning Commission for approval. This plan must include maps and analysis of ownership status, and an analysis of impacts the development would have on the zoned district. The same development proposal would also require numerous state and federal permits, and a comprehensive CMP consistency review would be initiated for the project.

The NSB Coastal Management Plan’s policies and development standards have been adopted verbatim into Title 19 of the Municipal Code. The NSB and all communities within would be affected by any increase (or decrease) in petroleum revenues derived from post-sale production.

2. Effects on Communities

a. Subsistence Use Patterns

Subsistence activities, including hunting and fishing, are described in Chapter Four. There is low potential for interference with hunting and fishing due to the timing of development or the placement of structures. Most recreation in the area occurs during summer, while development would occur during winter. If development occurs, major energy facilities must be consolidated, as required under the ACMP and area use conflicts would be reduced. The “visual, environmental, social, and economic effects are concentrated,” and are “less complicated and less costly” (ADCRA 1978:31). Impacts to Subsistence uses are discussed in previous subsections.

b. Physical Impacts and Access

At the lease sale phase there will be no physical impacts on municipalities and communities, except for administrative work involved in the transfer of some leases if those leases are jointly owned by the state and ASRC. For some residents, anticipation of future development conjures up images of opportunity, while for others it means that present activities and life-styles are threatened.

For activity on leases near Nuiqsut, residents may notice increased presence of company personnel. If a project is approved, residents may notice increased use of the community airstrip by small aircraft in earlier phases, and larger C-130 Hercules aircraft and helicopters during the construction phase. If the project site is remote, village residents may see and hear aircraft in the distance or may notice aircraft if the project site is near a traditional use site. In summer, residents may notice increased barge and supply vessel traffic offshore. They may also see and hear associated support vessels and helicopters.

Local residents' use of the sale area depends on access to the area. Development of the sale area could adversely affect human uses of the area and its resources if access to hunting, fishing, or trapping areas is restricted or if industry activities occur at the same place and time as these activities. For this reason, Mitigation Measures to protect use and access to resources are proposed. Conversely, development of the Sale

87 area could actually increase public access for users of the area's resources. If roads were constructed across state land, they might be open to the public and available for multiple use activities.

In winter, residents may notice or come upon construction work camps while traveling outside of the village. If a pipeline or road project was approved, they may have to steer clear of a pipeline project while it was under construction, but should be able to move freely about the region after production of oil or gas begins. If above-ground pipelines are proposed, they must be a minimum of five feet high. Residents may also see the use of ice roads by trucks and machinery in winter.

c. Occupational Change

An increase in job opportunities could pull residents away from other community-oriented occupations or responsibilities if the project were large. Residents who take oil field jobs or subsequent petroleum revenue-funded jobs may have less time to participate in subsistence activities. If the pattern of social change resulting from Prudhoe Bay and Kuparuk holds for this lease sale, it is unlikely that an increase in oil field jobs will erode the existing subsistence participation level in a community.

Some residents may be actively involved in construction camp and development site planning. They would be asked to provide information as to the locations of fishing, trapping and hunting camps, and historic sites, like graves which may be near a proposed development site. Some residents may participate in the construction and production workforce, especially on projects where NSB, and regional and village corporation companies have secured contracts with operators. Other residents would not be involved directly in effects of nearby development, but may be affected indirectly. For example, children and young adults may be affected if a parent who previously spent more time in the household now spent long days working at a project site. Some residents may feel that every day life is disrupted if, for example, instead of doing normal day to day activities, they felt compelled to engage in planning processes to protect village interests. Lessees are required to consult with community representatives if a proposed project has the potential to conflict with subsistence uses. Lessees are required to recruit local hire and contract with local service providers if available. They are also advised to include members of the community in their operations planning process. Additionally, they are required to conduct extensive wildlife and subsistence use studies before construction or production drilling is approved by agencies.

It is impossible to predict if any of these activities or effects will occur as a result of Sale 87, but if discoveries are made and a development project proposed, mitigation measures will be imposed on all plans of operation. Site or issue-specific restrictions may also be imposed by the state, NSB, or federal authority where jurisdiction applies. Additionally, if a project is proposed, a site-specific proposal must undergo a multi-agency ACMP review. Public input would be solicited in numerous hearings in affected coastal districts. Some residents would be involved directly, including local government employees and oil field workers, while others would choose not to participate at all.

d. Cultural Change

Throughout the era of oil development in the Arctic, local residents and community representatives have expressed concern that the integrity of Inupiat culture, with its basis in subsistence use, is threatened. Forces identified as converging upon the Inupiat way of life are: competing interests, oil and gas development, environmental degradation, access and use limitations, land tenure problems, socio-economic instability, and loss of cultural privacy (NSB, 1979b). These issues are still of concern today.

Some issues of concern can be addressed at the lease sale phase with mitigation measures, while others are beyond the scope of a lease sale. For example, land tenure and competing interests may have roots in the history of congressional action in Alaska, not in oil and gas development or production activities per se. Concern that environmental degradation, and access and use restrictions will undermine the subsistence way of life can be addressed in lease sale planning to the extent that they are caused by post-sale activities. Socio-economic stability as a goal of the state’s leasing program can be achieved through petroleum revenues, like oil and gas property taxes. This goal is further realized by ongoing efforts of the NSB to diversify its work force and economy so as to be less dependent on oil revenues.

That cultural change has occurred as a result of increased human presence on the North Slope cannot be denied. Western tools and institutions have altered traditional subsistence patterns. Today’s subsistence culture blends old and new, with cash wages used to supplant household income and income used to acquire modern machinery and supplies for subsistence activities. Thus, the potential for cultural change resulting from post-lease sale activities exists.

Measures to protect subsistence resources and maintain environmental quality, beyond protections already afforded by law are described in Chapter Seven. Minimizing, reducing, and avoiding impacts to the human environment are addressed below.

Mitigation Measures

The following are summaries of some applicable mitigation measures. For a complete, full text listing of Sale 87 mitigation measures see Chapter Seven. Lease sale plan of operation terms and lessee advisories that would mitigate potential impacts to municipalities and communities are:

- Environmental Protection -- Numerous measures are designed to protect environmental quality and the habitats which support important subsistence resources. Other measures are designed to protect key species, like caribou, whales, birds, and fish, from potential adverse effects of oil and gas activities.
- Access to Resources -- Restricting access to subsistence resources is prohibited under ACMP and local ordinances. Access to identified traditional use sites shall not be infringed. No restriction of public access to, or use of, the lease sale area as a result of oil and gas activity will be permitted, except within the immediate vicinity if drill sites, buildings and other related facilities. Any area of restricted access must be justified in the plan of operations.
- Subsistence Conflict Resolution -- Prior to initiating any activity which may disrupt subsistence harvesting, lessees must consult with the affected community before plans of operation can be approved. Lessees are advised to consult with the NSB when planning operations and generate potential solutions to problems. A discussion of resolutions reached and plans for continued consultation shall be included in the plan of operations. Lessees are advised that interfering with reasonable access to subsistence resources violates the ACMP and NSB Municipal Code.
- Community participation -- Lessees are advised to bring local residents into their operations planning process. Residents can provide critical input and traditional knowledge to operations and oil spill prevention and response plans. Community representation on management teams facilitate understanding and the transfer of information between the lessee and the residents.
- Cultural Awareness -- Lessees are required to conduct a training program for all personnel, including contractors and subcontractors, involved in any activity. The program must be designed to inform each person working on the project of environmental, social, and cultural concerns which relate to the individual's job. In addition, the program must also be designed to help personnel increase their sensitivity and understanding of community values, customs, and lifestyles in areas where they will be operating. The program must include an explanation of the applicable laws protecting cultural and historic resources.
- Protection of Historic and Archeological Sites -- prior to exploration activities involving ground disturbance, and subsequent development, lessees must conduct an archeological inventory. If any objects are discovered at any time, they must be reported, and appropriate protective measures followed.
- Economic Security -- Lessees are encouraged to employ local and Alaska residents and contractors. Plans of Operations must include a prescription for partnering with local communities in recruiting and hiring Alaska residents and contractors. Lessees are advised to bring local residents into their operations planning process. Residents can provide critical input and traditional knowledge to operations and oil spill prevention and response planning. Community representation on management teams facilitate the transfer of information, intentions, and values between lessees and residents.

D. Fiscal Effects

Financial effects are generated from (1) direct expenditures made by firms in connection with the lease, and (2) petroleum revenue taxes, and subsequent local and state government spending. Cumulative effects of industry expenditures and petroleum revenues are felt by state government and local governments and their beneficiaries.

Direct expenditures in turn stimulate ancillary spending in the economy as contracts for goods and services are fulfilled. Economic effects are generated by industry spending throughout the life of the project or field recovery. State revenues are generated immediately after the lease sale with bonus bids and first-year rents. After production begins, state revenues are derived from royalty and severance taxes, and oil and gas property taxes.

1. State Petroleum Revenues

Alaska's economy depends heavily on oil and gas related revenues and resultant government spending. The state government receives revenues from oil and gas lease bonus bids, rentals, and royalties; production taxes; and corporate income taxes. Lease sales ultimately generate income to the state in these ways. Some of these—bonus bid payments, rentals, and to a certain extent, corporate income taxes—are generated for each lease sold, regardless of whether a discovery is ever made or production established.

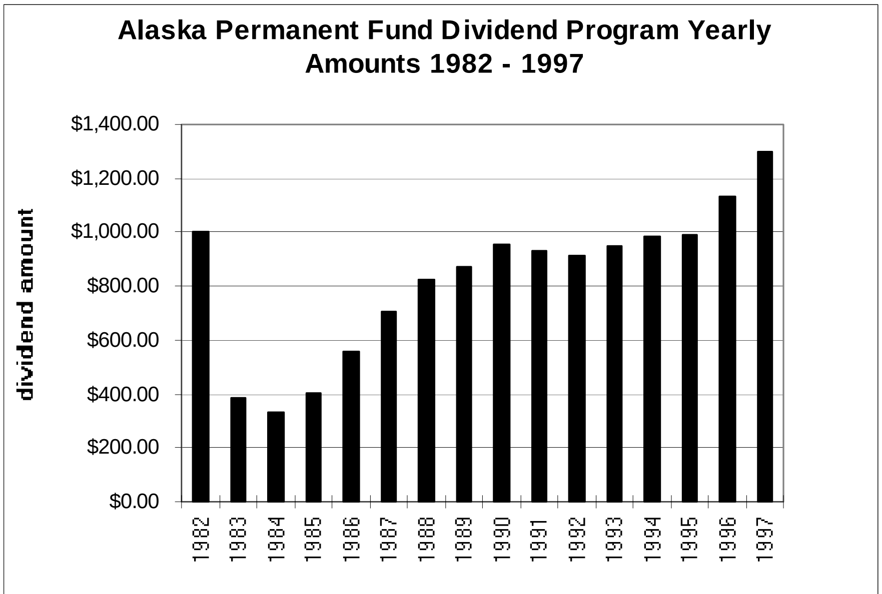
1. Bonus Payments. These are the amounts paid by winning bidders for the individual tract lease at a lease sale. Since 1959, 4,963 tracts have been sold, generating more than $1.95 billion in bonus bid income to the state.
2. Rentals. Each lease requires an annual rental payment. The first year rent is $1.00 per acre or fraction of an acre, and the rent increases in 50¢ increments to $3.00 per acre or fraction of an acre in the fifth and all following years of the lease. The lessee must pay the rent in advance and receives a credit on the royalty due under the lease for that year equal to the rental amount. Rental income for fiscal year 1997 amounted to $4.4 million (ADNR, 1997b).
3. Royalties represent the state's share of the production as the mineral interest owner. Royalty payments provided over $1 billion in revenue to the state in fiscal year 1997.
4. Production taxes. All producers must pay tax on all taxable oil and gas produced from each lease or property in the state on a percentage-of-gross value basis. For fiscal year 1997, oil and gas production taxes were $888.7 million (ADOR, 1997:34)
5. Income taxes. All corporations in the state must pay corporate income tax for all taxable income derived from sources within the state. Special provisions apply to apportioning total income worldwide for corporations involved in producing or transporting oil and gas. Most, if not all, producers and transporters of oil and gas in Alaska are corporations.

Together these revenues comprised approximately 75 percent of the state's general fund unrestricted revenue for the past 19 years, and 81 percent of the total generated fund unrestricted revenue in fiscal year 1997. Such revenues finance the state's revenue sharing, municipal assistance, education funding, operating budget and capital budget (ADOR, 1997:17)

State spending supports nearly one out of every three jobs, and three of every ten dollars of personal income result from state spending. Nearly one of every two local government jobs (including school district jobs) in Alaska relies on state funding (ISER 1990:1,4). Oil and gas royalties and revenues also contribute to the Alaska Permanent Fund, which pays significant dividends each year to every qualified state resident.

The Alaska Permanent Fund was established by ballot proposition in 1976. At least 25 percent of all mineral lease rentals, royalties, royalty sale proceeds, federal mineral revenue sharing payments, and bonuses received by the state are placed in the permanent fund. All qualified Alaskans who apply, receive an annual dividend from the earnings of the permanent fund. In 1997, every qualified man, woman, and child in Alaska received a dividend check of about $1,300. The PFD is an equitable benefit transfer because it reaches every individual regardless of income or socio-economic status (see Figure 5.5). The permanent fund continues to support Alaska families and the state economy.

Figure 5.5 Alaska Permanent Fund Dividends



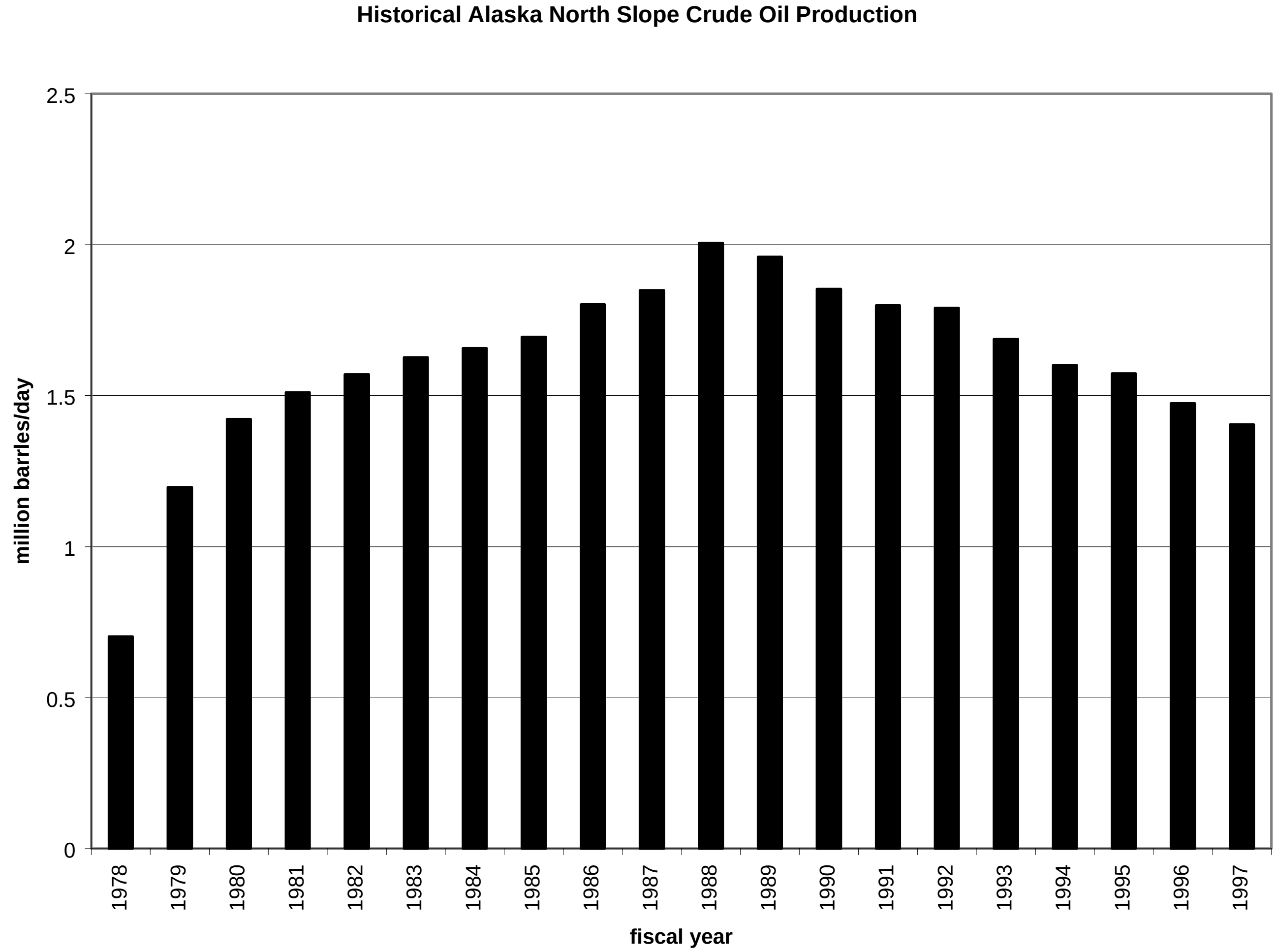
Source: ADOR, Permanent Fund Dividend Division

The total economic effect of any spending, including state government spending and salaries paid to private oil and gas industry employees, is always greater than the direct effect. When money is re-spent in the economy, its original value multiplies. For example, this "income multiplier" is calculated at 1.35 for state spending. This means that for every dollar of income Alaskans receive directly from state spending, an additional 35 cents of income is generated when that dollar is re-spent in the local economy (ISER 1990:3).

The primary source of state revenues is North Slope oil production. North Slope fields hold 98 percent of the state's known oil reserves and 90 percent of the state's known gas reserves. The remainder of state oil and gas reserves are found in Cook Inlet fields. However, oil and gas reserves are finite resources and North Slope production is declining (see Figure 5.6).

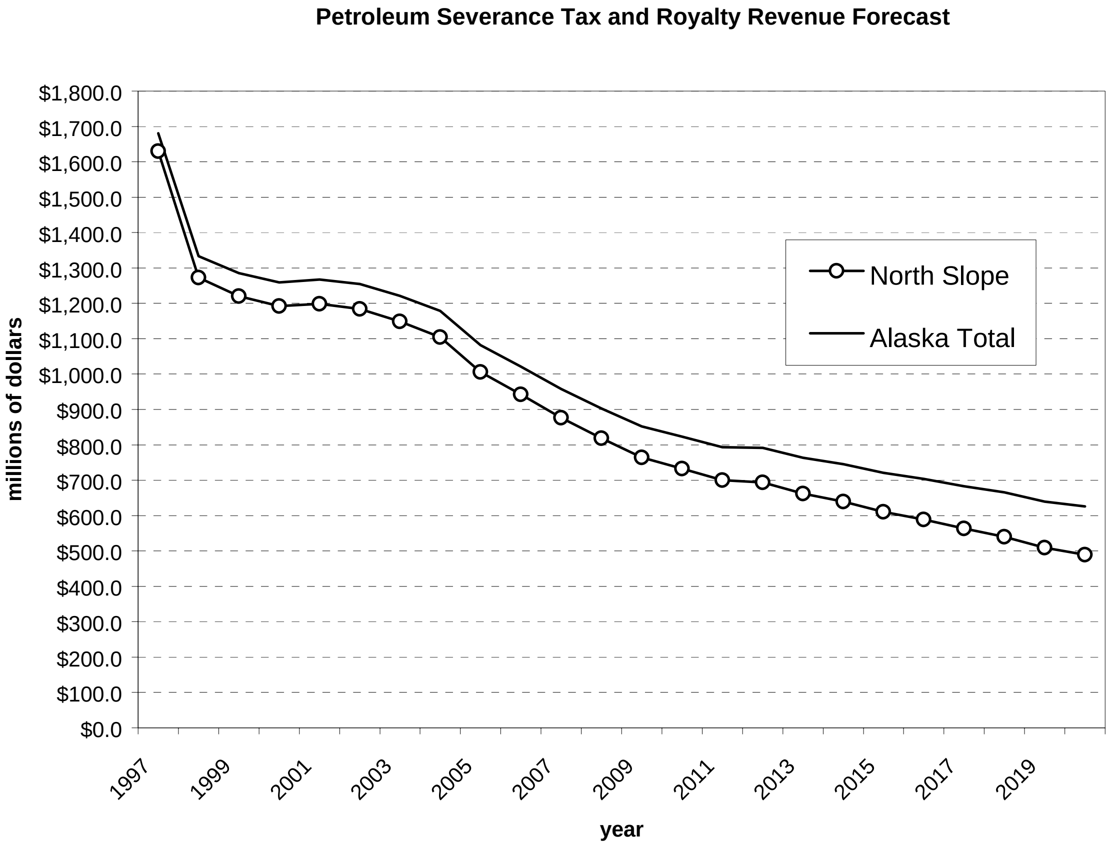
North Slope oil production has declined by approximately 600,000 barrels of oil per day (bpd) from its peak of approximately 2.0 million bpd in 1988 to an average of 1.41 million bpd for fiscal year 1997 (ADOR, 1997:43). The overall decline will accelerate, and production is expected to fall to 1,116 thousand bpd by 2005 and to 431 thousand bpd in 2019 (Beasley, 1998) (See figure 5.7). Annual production from Cook Inlet fields has been declining for many years. Cook Inlet production now averages approximately 32,000 bpd, down from a peak of 227,200 bpd average in 1970 (Beasley, 1998). These declines in oil production cause corresponding decreases in related revenues and seriously impact state government income and spending.

Figure 5.6 Historical Alaska North Slope Crude Oil Production



As a result of the sale, there may be a one-time increase in state income from bonus payments, and an annual increase from rental payments. Given the low to moderate petroleum potential in the sale area (described in Section II), the potential for additional revenue is unknown. ADNR does not know how many and which Sale 87 tracts will be leased. However, if only 5 percent of the tracts are leased, with a minimum bid of $5 per acre, the state can expect to receive $1.75 million in bonus bids. Historically, the amount of bonus bids varies considerably from tract to tract. The average per acre bonus bid in North Slope sales over the last five years has been $91.46. Using this average under a 5 percent leasing scenario, the state would receive over $32 million in bonus bids. If 5 percent of tracts offered were to be leased, over the term of these leases (assuming seven years), the state could expect to receive up to $5.6 million in rental income. This is revenue the state would receive regardless of whether there is any development.

Figure 5.7 Alaska Oil and Gas Severance Tax and Royalty Revenue Forecast



2. Effects of Industry Investment

The amount that industry invests depends on the expected return on each dollar invested. Projects in Alaska often compete with projects in other parts of the world for the same investment dollars. The lower the investment dollar per barrel of recoverable reserves, the higher the likelihood that project expenditures will be made. A project's development costs plus the costs of production over the life of the field are estimated and compared to the total volume of recoverable reserves. Some estimate of the price per barrel is selected, and return on investment dollar is calculated by the lessee. If the return rate is high enough, then the project commences, oil or gas is produced, and oil royalties and production taxes are realized.

Investment dollars go into three basic spending categories: labor (including wages and salaries paid to workers and contractors), equipment and supplies, and services. Oil and gas firms contract with other firms for goods and services, some of which can be obtained from Alaska vendors, while others are contracted out of state. Direct expenditures in turn generate other indirect expenditures in the economy.

The number of tracts that will be leased in a particular sale is impossible to predict, because of the competitive nature of the leasing process. Exploration and development expenditure levels vary by project. Expenditure patterns depend on the type of project, such as remote or marginal field development or remote exploration. A remote field development project would spend a higher proportion of total costs on transportation services and road or pad construction. Estimates (used by the Alaska Oil and Gas Policy Council for an input-output model of the state's economy) based on survey data indicate that up to 80 percent of exploration and production expenses are made in-state, while appraisal, remote development, marginal development, and enhanced oil recovery expenditures rely more on out-of-state contractors (AOGPC, 1995:35). For example, if the average cost to drill a well was $2.5 million, then about two million dollars would likely be spent in-state on that well.

The remote field scenario in the AOGPC study involves an extensive amount of exploration activity. "Historical data indicate that approximately 25 wells would be required to discover a remote field large enough to support the necessary infrastructure and be commercially viable" (AOGPC, 1995:32). Production activities require more services and less construction than exploration and development scenarios. Direct and indirect expenditures by category for typical project scenarios from AOGPC are in Table 5.2.

Table 5.2 Distribution of Direct and Indirect Industry Expenditures

Industry	Remote Field Development	Remote Exploration
Manufacturing	34%	17%
Transportation	10%	6%
Services	20%	16%
Construction & Other	7%	34%
Communication	7%	9%
Trade	10%	8%
Finance, Insurance & Real Estate	12%	11%

From: AOGPC, 1995

3. Effects on Municipal Finance

Under the umbrella of the state constitution, local government is provided the powers of land use zoning and taxation. Although some North Slope Borough funds are derived from revenue sharing programs with the state (see Table 5.3), borough revenues are primarily generated from taxes on residential, commercial, and oil and gas properties. These revenues fund capital improvement projects and community services such as education, public safety, planning, and health care, and allow the borough to employ local residents (see Table 5.4). In 1991, the NSB Assembly was able to repeal the sales tax as a result of an agreement by the major North Slope oil producers to pay the NSB an additional $5 million per year for five years.

Table 5.3 State Revenues to North Slope Borough communities, FY 96

Municipality	Revenue Sharing	Other State Revenue	Total
North Slope Borough	$381,977	$9,673,183	$10,055,160
Anaktuvuk Pass	31,720	23,820	55,540
Atqasuk	31,720	26.038	57,758
Barrow	110,229	189,865	300,094
Kaktovik	31,720	9,314	41,034
Nuiqsut	31,720	14,086	45,806
Point Hope	25,430	82,832	108,262
Wainwright	31,720	42,068	73,788

Source: ADCRA, 1998

Note: Other state revenues include State Safe Communities program and do not include education funding.

Oil and gas production activities from existing discoveries already comprise a significant percentage of the NSB economy and tax base. Approximately 98 percent of the borough's property taxes come from assessments on the oil industry (ADCRA, 1996a). However, the NSB is dependent on revenue tied to production from oil fields that are in decline. At present, it is facing a non-increasing revenue base. The current assessment of property values related to the oil and gas industry within the borough is approximately $12 billion, down from a peak value in 1987 of about $13.5 billion (MMS, 1990:79, 85, 97). This includes the segments of TAPS (containing the first 177 miles of the pipeline, including support facilities) which lie within borough boundaries.

Table 5.4 North Slope Borough Employment Profile

NSB average monthly employment and earnings, 1996.

Industry	Workers	Av. Monthly Earnings
Mining (Oil and Gas)	3,548	$6,741
Construction	344	$6,124
Trans/Comm/Utilities	428	$5,869
Retail Trade	524	$3,159
Services	890	$3,080
Federal Government	43	$3,584
State Government	57	$4,320
Local Government	2,286	$3,480
Finance, Insurance, Real Estate	143	*
Total:	8,263	

* Is used to avoid disclosure of data for individual firms.
Source: Alaska Department of Labor, 1997

In preparation for declining tax revenues, the NSB has established a permanent fund. Whenever the borough government's income exceeds expenditures, the surplus is added to the existing fund's investment base. For the fiscal year 1996-97 the value of the fund was approximately $361 million (NSB, 1997:80). Earnings from investments are earmarked to provide public services. In FY 1996-1997, the fund earned $48.4 million (NSB, 1997:vi).

Jobs in the NSB rely on government and industry spending. Government employment (federal, state, and local) accounted for 2,386 full time permanent jobs. Next to the oil industry, the NSB is the region's principal employer. Borough employment policies encourage that local residents be hired for borough funded community projects.

As exploration takes place, and if development occurs, the sale would add jobs to the local economy. These jobs would not be limited to the petroleum industry, but would be spread throughout the trade, service, and construction industries. However, the number of jobs produced would depend on whether commercial quantities of oil and gas are discovered and developed. Discovery and development of commercial quantities of petroleum or natural gas in the Sale 87 area would bring direct economic benefits to the local and regional economy.

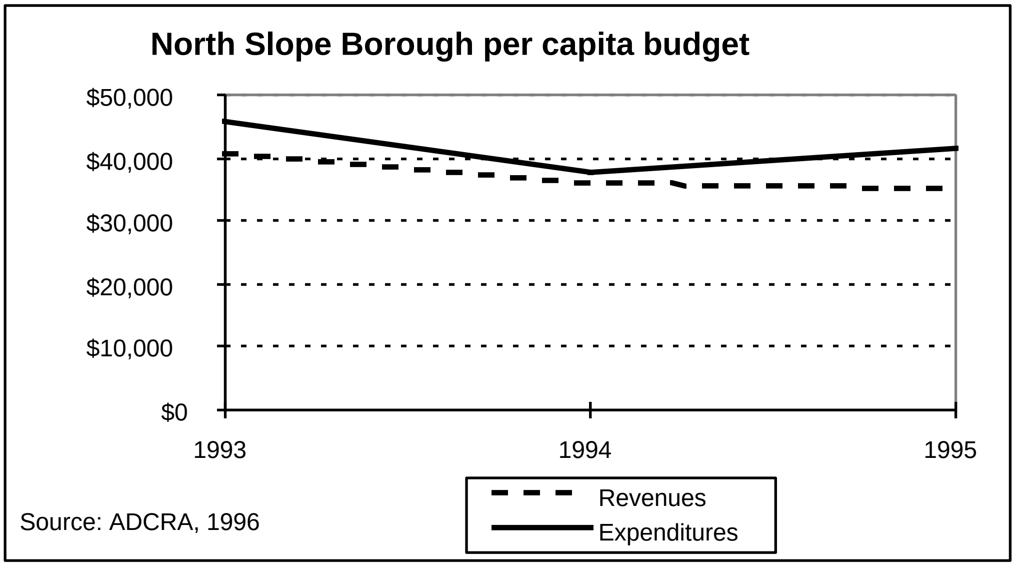
Local government plays a major role in the health, education, and living standard of village residents, and is the main engine of the cash portion of the economy. This engine is fueled by local taxes and state and federal revenues. The budget for the NSB includes an operating budget and a capital budget.

a. NSB Revenues

Local revenues include oil and gas property and other property taxes, license permits, service charges, enterprise revenues, bingo receipts and other local revenues. Service charges may include airport operation contracts, rents on leased property, and oil related service charges. Enterprises include water and sewer systems, washeterias, garbage collection, electric service, cable TV, fuel and gravel sales, and revenues from the Kuparuk Industrial Center, Barrow Gas Fields, and Service Area 10 (ADCRA, 1996b). The Kuparuk Industrial Center was sold in 1997 (NSB, 1997).

State revenues include revenue sharing, municipal assistance, and other revenues. State revenues include operating grants for health and social services, such as suicide prevention, alcoholism treatment, child and senior care programs (ADCRA, 1996b).

In 1995, the NSB derived 77 percent of its operating revenue from oil and gas property taxes (ACRA, 1998)(NSB, 1997), which translated to about $36,000 in total revenues per capita. Between 1993 and 1996, per capita spending exceeded revenues (See figure below). Revenues to the NSB are expected to decline in the future as existing oil fields, including Prudhoe Bay and Kuparuk are depleted, infrastructure shrinks, and the value of taxable oil and gas exploration, production, and transportation property declines. In light of this decline, the NSB has launched initiatives to develop new oil and gas resources, diversify its economy and labor force, and reduce dependency on oil dollars (NSB, 1993).



In 1995, only 70 percent of total operating revenue came from oil and gas property taxes; an indication that efforts to diversify are succeeding (ADOR, 1996). Oil and gas lease sales provide the mechanism for economic diversification by generating local revenues, which can be reinvested in self-sustaining enterprises.

In 1996, the assessed value taxable property was $11.7 billion, representing a decline of $150 million from the previous year (NSB, 1997). In 1995, property tax revenues for the borough were $3,753,201, and oil and gas property tax revenues were $223,520,017, for a total tax revenue of $227,273,218 (ADCRA, 1998). The borough's 1996 revenues and expenditures are depicted in tables 5.5 and 5.6.

Table 5.5 North Slope Borough Fiscal Year 1996 Revenues

Operating	Local	Local Taxes	$228,097,544	
		Service Charges	$10,811,177	
		Enterprises	$12,499,576	
		Other Local Revenues	$44,102,601	$295,510,908
	State	Revenue Sharing	$381,977	
		Other State Revenue	$9,674,183	$10,055,160
	Federal		$5,000,000	$5,000,000
	Other (State and Federal Education Funding)			$22,898,248
Capital				$1,790,640
Total				$335,254,956

Table 5.6 North Slope Borough Fiscal Year 1996 Expenditures

Operating	General Government	Admin & Finance		$64,030,433
	Public Safety			$15,161,325
	Public Services	Health	$21,800,288	
		Misc. Pub Services	$51,374,291	
		Education	$44,570,282	$117,744,861
	Debt Retire			$165,652,305
Capital				$126,120,047
Total				$488,708,971

b. NSB Expenditures

Total expenditures in 1996 were $346 million, 47 percent of which went to debt retirement. Other expenditures went to pay for general government, public safety, housing, wildlife management, health and social services, and municipal services. General government spending includes municipal council, administration and finance, planning and zoning, and other general government expenditures. Public Services include parks and recreation, health care, library and museums, water, sewer, phone, electricity, mass transit, airports, harbors and docks, and ice and gravel roads (NSB, 1997)

c. Capital Projects

In 1995, the borough spent about $126million on capital projects and more than $143 million in the following year. The NSB has numerous capital project funds. Capital project spending in FY 1996-1997 included the following:

Table 5.7 North Slope Borough FY 1996-1997 Capital Projects Funds

Fund	Expenditures
Education and Services Center Facilities	$17,559,712
Public Roads, Watercourse and Flood Control Facilities	11,720,771
Public Housing	15,063,841
Water Facilities	26,800,323
Sewage Treatment Disposal Facilities	19,413,768
Airport and Airport Terminal Facilities	1,689,618
Urban Development Projects	90,141
Light, Power and Heating Systems	21,331,600
Public Safety Facilities	8,559,674
Sanitary Facilities	2,361,768
Communications	441,283
General Capital Projects	2,561,006
Health Facilities	4,443,849
Library/Cultural Facilities	6,873,617
Administration Facilities	4,424,916
TOTAL	$143,335,887

Source: NSB, 1997

d. Education

The North Slope Borough School District is operated and funded by the borough with state and federal funds and borough funds. Between 1993 and 1995, state and federal funding for education declined 2.3 percent, while borough funding increased 40 percent to cover the loss and pay for an overall increase in education costs of 16.8 percent for that period (ADCRA, 1996b). See table 5.7. In 1996, the NSB spent $44,570,282 on education, of which $22,898,248 (51 percent)came from state or federal sources (ADCRA, 1998).

Table 5.8 North Slope Borough Education Costs

	Funding Source		
	State and Federal	Local	Total
1993	$20,867,142	$17,184,850	$38,051,992
1994	$20,596,946	$19,294,227	$39,891,173
1995	$20,377,720	$24,071,929	$44,449,649
1996	$22,898,248	$21,672,034	$44,570,282

Source: ADCRA, 1996b

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